RESEARCHES IN THE NERVOUS SYSTEM

OF

MYXINE GLUTINOSA.

BY

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Researches in the Nervous System of Myxine glutinosa.

By Alfred Sanders, *M.R.C.S., F.L.S.*

I am indebted to the authorities of the zoological station at Granton for an opportunity of procuring specimens of *Myxine glutinosa*, and I take this opportunity of thanking them for allowing one of their officials to accompany me to the spot where these animals abound, and to afford me such information as to enable me to mark the place on my chart.

Myxine glutinosa appears to be especially abundant at the entrance of the Firth of Forth, but the distribution seems to be limited, as at Berwick-on-Tweed, a place only about fourteen miles distant, the fishermen knew nothing about them. At the spot indicated, however, they swarmed, and two hours sufficed to fill some half-dozen traps to overflowing.

Since the illustrious Johannes Müller published his dissections of the Myxinoids, very little has been written on that family; in addition to the Morphological Papers of Cunningham, and the researches of Fritjof Nansen and Retzius on the spinal cord of *Myxine*, and one or two more, all other papers on the Cyclostomata have been concerned with the family Petromyzontidæ.

I found it very difficult to make the nervous tissue hard enough to be sectioned. A year in solution of potassium bichromate was not too long, and the spinal cord was still soft even after that period; indeed it was necessary to use Erlicki's fluid in order to get the latter hard enough to make tolerably fine sections.

The stain I used principally was the aniline dye known in commerce as soluble blue; it is not to be supposed, that because I adhere to this stain, that I have tried no other. From time to time I have employed all the chief methods, but have found that, with few exceptions, soluble blue shows as much as, if not more than, any other stain.

The exceptions are some that work in a different way, with Golgi's chromo-silver method I have not been successful in the case of *Myxine*, and cannot show figures resembling those given by Nansen, probably because my material had been too long in potassium bichromate solution; but the wonderful results gained by Gustav Retzius* with the aid of Ehrlich's methyl blue when applied to the living animal it is hopeless to emulate, at least until I have an opportunity of procuring fresh material. I have not tried Weigert's hæmatoxylin method in *Myxine*, as it stains the

* No. 372 in list.

medullary sheath only, and the nerves in this animal do not possess that structure, so that the process in question would probably be without result.

The Skull.

The skull in *Myxine glutinosa* is entirely devoid of either osseous or cartilaginous tissue, but is formed of thick fibrous membrane, with the exception of the ear capsules, the base of the skull between them, and the trabeculæ, which are all cartilaginous. Dr. A. RETZIUS* described a colourless transparent lamella of cartilage outside the fibrous skull, but probably he referred to the base, as he remarked, that it was found especially below.

Beneath the fibrous membrane forming the outer framework of the skull lies the dura mater (fig. 2, *d.m.*), which itself is also fibrous, and is divided into several layers; anteriorly these layers are united together, and are attached to the skull on the posterior margin of the olfactory sac. The space between the layers of the dura mater, and between the internal one and the external surface of the brain, is filled by a species of undeveloped connective tissue, which has a jelly-like and finely granular appearance, and in some places shows obscure indications of fibrillation.

Blood sinus.

A large blood sinus (fig. 5, *b.v.*), extends along the central line of the dorsal side of the brain in a longitudinal direction, not following the contour of the brain, but passing from the summit of one tuberosity to that of the next in front of it. Above the upper edge of the third ventricle, this sinus divides into two branches, which again divide into numerous capillaries forming a spongy tissue or choroid plexus (figs. 3 and 4, *c.pl.*), which extends to the anterior end of the cerebrum, to the depression between the latter and the olfactory lobe. This structure does not homologize with the epiphysis, but rather with the choroid plexus.

MÜLLER has figured a body distinctly projecting from the upper surface of the brain in a corresponding position in *Bdellostoma*; anything resembling this is not to be seen in the brain of *Myxine*, where there is no projection above the general level of the dorsal side of the brain. It might probably be the epiphysis in *Bdellostoma*, but MÜLLER does not explain it.

These facts show that the epiphysis is not developed in *Myxine*, and *a fortiori* there are no indications of the pineal or parietal eye, a fact which might be thought strange, considering how well developed this structure is in Petromyzon, in which animal it was first described by AHLBORN†, and afterwards by OWSJANNIKOW‡, and others. This organ, however (which BÉRANECK§ has shown to be distinct from the epiphysis,

* No 23. † No. 246. ‡ No. 320. § No. 278.

although originally developed therefrom), appears to have rather an arbitrary distribution. As BALDWIN SPENCER has shown in his elaborate memoir, it is well developed in *Lacertilia*, but it is not found in any of the higher fishes, neither in *Ceratodus*, *Elasmobranchii*, nor in *Teleostei*; then it suddenly appears in the low form Petromyzon as well developed as in many lizards, and in some respects the latter may be considered even better provided with these organs, as it possesses two parietal eyes, so that if these were ever functional at the same time, this animal had four eyes. This has been shown by OWSJANNIKOW,* who has demonstrated that the internal body in the animal in question presents nearly as good a retinal structure as the external body.

If the membrane mentioned above represents the dura mater, as seems probable from its being in closer relation to the skull than to the brain, then the pia mater is not present in this animal, unless the undeveloped jelly-like tissue (figs. 2, 3, 4, 5, *p.m.*) may be supposed to represent it; this idea is rendered probable by the fact of its carrying the blood-vessels destined to supply the brain.

This seems to be the proper place to mention a structure (figs. 3 and 4, *o.m.*) which is not found elsewhere than in *Myxine* and *Petromyzon*, although it is only indirectly connected with the skull or membranes of the brain; this is a tube which, opening in *Myxine* at the extreme dorsal edge of the upper lip, passes backward to the olfactory sac, where it is divided by a horizontal partition into two stages, the upper of which passes into the olfactory sac, the lower one passes backward beneath the base of the skull to enter the branchial apparatus. It appears to have been known as far back as 1822,† as Dr. RETZIUS† mentions it in his paper on *Myxine glutinosa*. It is this structure which Dr. BEARD‡ looks upon as the remains of the original vertebrate mouth. Without expressing an opinion as to the merits of the rival theories of the origin of the Vertebrata, I may mention here that there is no communication whatever between this tube and the hypophysis cerebri, at least in the adult specimens that I have worked upon.

The glandular hypophysis in this animal was recognized by J. MÜLLER,§ who saw the depression in the base of the skull in which it is situated. At the point where this structure is imbedded the walls of the skull are membranous. This body is quite isolated, for, just as it is divided off from the above-mentioned tube by the membranous base of the skull, it is also divided from the infundibulum above by the epithelial lining of the same.

In the vertebral canal—or, to be more exact, in the canal of the chorda dorsalis—the space not occupied by the spinal cord is filled by a tissue, which forms meshes in such a way as to give the appearance of large cells, and causing it to resemble the connective tissue which exists immediately beneath the skin; toward the external edge this tissue is finished off, as it were, by a thickening of its substance, which

* No. 320. † No. 23. ‡ No. 302. § No. 48.

makes a firm border, of membranous consistence, exactly filling the dorsal part of the canal, following the contour of what in higher Vertebrata would be the dorsal arches.

The meshes of this quasi-cellular tissue are filled by a substance resembling the undeveloped connective tissue which fills the space between the outer surface of the brain and the dura mater. FREUD* terms this substance arachnoid; whatever it may be in *Petromyzon*, it is not arachnoid here. For one thing, it is not a continuous membrane, but a continuous areolar tissue. How far it corresponds to the tissue which GASKELL† supposes to be the degenerate remains of the Arthropod liver, I am not called upon to decide here.

The Brain.

The external aspect of the brain shows but slight indications of division into parts.

The olfactory lobes (fig. 1) are distinctly separated from each other by a longitudinal fissure which extends completely from above downward; they are separated from the cerebrum behind by a very shallow transverse furrow.

The two lobes of the cerebrum are separated from each other by a deep fissure which gradually becomes shallower at its posterior end.

Longitudinally, the cerebrum passes without division into a pair of tuberosities behind, which occupy a position corresponding to that of the tubercula intermedia of GOTTSCHE.‡ These tuberosities are much larger, in proportion to the other parts of the brain, in this species than in any other family of fishes. Between the two lobes of these tuberosities a ganglion is situated, consisting of small cells or nuclei; anteriorly this ganglion projects free into the fissure separating the two lobes of the cerebrum from each other, but posteriorly it is immersed in the parenchyma of the tubercula intermedia. The structure and supposed homology of this ganglion will be considered further on.

Behind the tubercula intermedia, and separated from them by a deeper depression and a central pit, which latter is occupied by a part of the longitudinal blood sinus, are situated two bodies which correspond to the position of the corpora bigemina; these end posteriorly in a point, and are embraced laterally by a pair of converging processes proceeding backward; these belong to the medulla oblongata and represent the corpora restiformia, giving origin at their anterior extremity to the trigeminus.

It is remarkable that the cerebellum, which in other fishes would occupy the space between these two diverging processes, the corpora restiformia, is here entirely absent, and that these processes do not join the posterior pair of tuberosities. This fact was recognized by A. RETZIUS§ as far back as the year 1822.

The medulla oblongata, which is formed by the two restiform bodies and the

* Nos. 169, 174. † No. 347.
‡ No. 39. § No. 23.

depression between them, the sinus rhomboidalis passes gradually into the spinal cord, changing its form, through cylindrical, to that of an open book turned down on its face.

Olfactory lobes.

The distinctive mark of the olfactory lobes in all vertebrata is the presence of glomeruli olfactorii, which were first discovered by LEYDIG* in the *Elasmobranchii. Myxine* is no exception to this rule, indeed they are more highly developed even than in some *Teleostei,* although not more so than in *Elasmobranchii* and *Ceratodus.* In *Myxine* these lobes are the only parts of the brain (except the ganglion habenulæ) which show any distinctive histological character. This is in accordance with the degenerative nature of these animals, and their semi-parasitic habit. As they are totally blind they depend upon their sense of smell for detecting and following their prey. That their sense of smell is acute is shown by their discovering the small aperture of the wooden boxes used as traps, in the darkness of midnight and at a depth of 34 fathoms of water; this proves that they could only have been guided by the scent of the fresh herrings used as bait. Their semi-parasitic habit is demonstrated by their entering the mouth of fish caught by the long line, and remaining in the abdominal cavity until the whole interior parts are consumed and nothing but the skin is found attached to the hook when the line is hauled in.

The glomeruli olfactorii are arranged along the dorsal and anterior edge of the olfactory lobe; along the ventral edge they do not extend so far back. As in *Elasmobranchii* and *Ceratodus,* they are composed of granular matter, with very fine fibrils resembling those that permeate the neuroglia of the cerebral hemispheres, but bound up specially into a very compact knot of an oval shape. In *Myxine* they are entirely composed of the knot of fibrillæ, but in Petromyzon occasionally a small cell is found in the centre. RAMON Y CAJAL, by using GOLGI'S method, has recently shown that the fibrils composing this knot are derived from the small cells which are found on the outer side of the glomeruli, but I have been unable to procure the publication in which he mentions it.

The external end of a glomerulus gives origin to a bundle of fibres, which, with those from the other glomeruli collect on the superior and anterior surface of the lobe, and pass out through a foramen, one on each side of the central partition of the olfactory sac, and running along the dorsal surface of the same, are distributed in small bundles which descend on the lamellæ toward their ventral edge. In the region where the glomeruli occur they are placed in close apposition, and are arranged, as before mentioned, along the edge of the lobe, and the spaces between them are occupied by small rounded cells.

In *Teleostei, Elasmobranchii,* and *Ceratodus,* the remaining elements of the olfactory

* No. 81.

lobe are arranged in layers, which in section present the appearance of a regular stratification; but here they occur in an irregular manner, and no definite layers are to be met with; nevertheless the same sort of elements occur. The principal components are fusiform cells, which exist in the course of rather thick fibres running in a longitudinal direction at various levels of the lobe, and which are not collected into bundles as in *Ceratodus.**

The neuroglia, which is permeated by a network of very fine fibrils, occupies the whole extent of the lobe; through this run the processes of the above-mentioned fusiform cells; they are distinguishable from the fibrils of the neuroglia by their larger dimensions. Cells of a smaller size, which show a tendency to accumulate in groups, are also scattered through the parenchyma. The fibrils of the neuroglia incline rather to pass in a longitudinal direction, they are coarser than those which occur further back, the interstices are occupied by a finer network, the transverse fibrils of which have a predominance.

Cerebrum.

The transition from the olfactory lobes to the cerebrum is quite gradual, there are no distinct crura passing into the latter, but there is a general drift of fibrils in a longitudinal direction. There is nothing in the structure of the cerebrum to distinguish it from the tuberosities that come after it; and this structure is not very complicated. In the cerebrum there is externally a layer of finely granular neuroglia with a network of fibrillæ permeating it, which, as a rule, is finer than the network in the interior. This layer is wider on the dorsal than on the ventral surface, where it extends quite into the olfactory lobes.

There are small rounded nuclei scattered sparingly through the external layer, and occasionally, also, fragmentary rows of small cells, having an epithelial aspect, occur. They appear to have wandered in from the outside, for they occur, not on the surface, but more or less surrounded by neuroglia; they are triangular or conical in shape, their broad end is turned toward the outer surface, and their pointed end gives off a process which goes toward the parenchyma of the interior just in the same way as the cells of the epithelial covering of the brain, first described by STIEDA† and termed by him "stiftzelle," only instead of being on the surface they are situated a short distance below it. They appear to correspond to the expanded ends of the processes of the neuroglia cells, which are brought out by GOLGI's chromo-silver method.‡

Toward the inner side of this external layer the fibrils of the network form transverse concentrically arranged bundles which are more or less apparent at different parts; in some places there are three of these concentric bundles, separated from each other by short rows of small nuclei; the external part of the network is irregular, and forms close meshes.

The external layer (fig. 12) of neuroglia is sharply distinguished from the interior part

* No. 339. † No. 132, p. 154. ‡ No. 384, taf. 8, fig. 2.

of the section by the presence in the latter of numerous cells and nuclei which are imbedded in a neuroglia, having a network of coarser fibrillæ than those of the outer layer. Most of the cells are bipolar, but occasionally tripolar cells occur. In some parts the cells are arranged in groups forming a sort of pattern in which several cells are placed close together, but separated from other similar groups by a space filled with the ordinary neuroglia characteristic of the part; this somewhat resembles the arrangement found in the cerebrum of *Raia*, though it is not so prevalent, for here the cells and nuclei often occur singly.

The bipolar cells are occasionally arranged in such a way that their long axes are directed perpendicularly to the outer surface, and they are often placed so as to make rows of cells indistinctly discernible, with their processes going in the same direction. The cells (fig. 14), as a rule, have each a large circular nucleus, in which granules of chromatine are grouped round the circumference, leaving a clear space in the centre, in the middle of which is a nucleolus; the cell-body is much less deeply stained than the nucleus, and passes off at each end into a process, that of one end being often wider than that of the other.

Other cells of a smaller size show less cell-body; they have finer processes, and the nucleus occupies nearly the whole of the cell; sometimes only a little conical piece is visible at the point of attachment of the two processes. These smaller cells are generally of about the same size as the nuclei of the larger ones. The dimensions of the larger cells vary from 0·02 millim. to 0·034 millim. in length, while the nuclei range from 0·01 millim. to 0·017 millim. in diameter, which latter measure, as a rule, gives the diameter of the cells.

In addition to these cells, free nuclei occur in considerable numbers throughout these tuberosities. The smallest of these nuclei measure 0·007 millim. in diameter; these become more deeply stained than the others. From this size every gradation is met with up to the dimensions of the nuclei of the cells, the largest found being 0·013 millim. in diameter; occasionally some occur with one diameter slightly longer than the other.

The two pairs of tuberosities which follow behind the cerebrum present a repetition of the same structure; the same sort of bipolar cells are scattered throughout these divisions. Like the cerebrum, they are bounded externally by a corresponding layer of smooth neuroglia, which is a continuation backward of that found in the first-mentioned tuberosity; the same sort of network of fibrillæ is visible, the meshes of which have a tendency to run parallel with the surface, and in which a few nuclei occur, either singly or in groups of two or three. This layer is distinguished histologically, in the same way as in the cerebrum, from the interior part of the tuberosities.

The lobes which come next behind the cerebrum correspond, as before mentioned, to the lobes which in the Teleostean brain were termed by GOTTSCHE* the tubercula intermedia, and by FRITSCH† were compared to the ganglia habenulæ, and might,

* No. 39. † No. 175.

perhaps, homologize with the optic thalami; if size alone be considered, they are much more developed here than in the *Teleostei.*

There is a peculiar ganglion (fig. 3, *g.h.*) situated at the bottom of the shallow groove which separates the two lobes of the tubercula intermedia; it is buried in the parenchyma, projecting very slightly above the external surface on the dorsal side, but forming at its anterior end a small rounded eminence at the bottom of the posterior end of the fissure which separates the two lobes of the cerebrum. It is pointed below and broad above, like a wedge, and extends from the posterior end of the cerebrum nearly to the anterior end of the corpora bigemina. Its pointed lower edge extends a little more than one-third of the distance to the lower edge of the lobe. The structure of this ganglion consists of small spherical nuclei, arranged horizontally and transversely in layers, alternating with bundles of parallel transversely-directed fibrils. Most of these nuclei are smaller than those which are found in the parenchyma of the cerebrum and the other tuberosities; their size ranges from 0·006 millims. to 0·0086 millims. in diameter; they give off processes which join the transversely-directed fibrils. This arrangement occurs in that part of the ganglion which is embedded in the parenchyma of the tubercula intermedia; but at the anterior end of the ganglion, where it projects at the bottom of the cerebral fissure, the fibrils form an irregular network.

The transverse bundles of fibrils (fig. 13), above mentioned, form a veritable commissure, the lateral terminations of which are lost in the parenchyma of the interior of the tubercula intermedia; the position of these bundles seems to indicate that they homologize with the posterior commissure of the brain, and the parenchyma in which they are lost would correspond with the optic thalami. The ganglion itself is probably the ganglion habenulæ, but in addition it is just possible that it may homologize with the tori longitudinales of the tectum lobi optici of *Teleostei*; the elements of one very much resemble those of the other, and both have a transverse commissure running through it, and if one imagined the ventricle of the optic lobe filled up in *Teleostei*, we should have a structure resembling this ganglion. But the fact that the tori longitudinales are double, whereas the ganglion in question is single, but above all, its position so far in advance of the corpora bigemina militates against this view of its homology. Within the last few years Dr. Auerbach* has made a discovery which may throw some light on this question. In the young trout he found and figured a column of cells occupying the dorsal edge of the tectum lobi optici; beginning forward over the third ventricle it extends to above the oculomotor ganglion. He found that this column of cells did not develop into the torus longitudinalis, the origin of which he could not discover. This discovery has not been confirmed as far as I am aware of, but it is just possible that it indicates the origin of the ganglion in question.

Two bundles of fibres (fig. 4, *m.b.*) pass downward and backward from the inferior

* No. 300.

side of this ganglion, and terminate in a small accumulation of smooth neuroglia, with nuclei scattered through it; it is situated in the mid-line at the anterior end of of the medulla oblongata, or what AHLBORN* terms the epichordal division of the brain. These are the so-called Meynert's bundles, which are well-developed in amphibia according to OSBORNE†; MAYSER‡ considers that they correspond to the part termed by FRITSCH§ vinculum gelatinosum centrale plus vinculum gelatinosum intermedium; the collection of neuroglia to which they extend would be the ganglion interpedunculare (figs. 2, 4, and 5, *g.i.*), or conus post commissuralis of FRITSCH. AHLBORN appears to have traced these bundles farther back, even into the medulla oblongata in *Petromyzon*, and in *Myxine* they did not seem to stop at the ganglion interpedunculare, but I could not find them in sections cut more posteriorly.

Spinal Cord.

The spinal cord commences posteriorly, in most specimens by a more or less pointed extremity behind the posterior termination of the chorda dorsalis, at this place the spinal cord is surrounded by a sac formed by the continuation of the membranes of the cord; here the latter is composed solely of the central canal and its lining of endothelium. The central canal debouches into this terminal chamber by a small aperture, and receives the central rod, which enters here. The central canal thus begins posteriorly with an aperture, and not by a cul de sac, as is stated by RAUBER‖ to be the case in fishes; this open state of the central canal is perhaps the remains of the channel which is found in the embryos of *Elasmobranchii, Amphibia*, and, apparently in *Ichthyopsida* generally.¶

The rod found in the central canal of fishes, which was first discovered by REISSNER,** has received various interpretations, some authors looking upon it as a sort of axis cylinder, others, as merely the coagulation of the fluid of the central canal. Here it is particularly well developed, and has, in places, a curiously twisted appearance, In some specimens the chamber above-mentioned, at the posterior end of the spinal cord, is occupied by a mulberry-shaped mass of glass-like aspect, from which, as from a knotted end, the rod in question emerges, in other specimens the end of the rod is attached to the surrounding connective tissue.

The central canal at first is single, but proceeding forward it shortly divides into two canals, an upper and a lower, connected with each other by a vertical passage, giving to the canal the shape of a dumb-bell; here it resembles the section of the lower end of the human spinal cord.†† At this point both canals are surrounded by endothelium, and the rod occupies the lower of the two. From this part forward, the central canal is double, and the lower only has an endothelium of cylindrical cells, the upper being

* No. 238. † No. 319. ‡ No 215, p. 357.
§ No. 175. ‖ No. 162. ¶ No. 171.
** No. 102. †† QUAIN'S 'Anatomy', vol. 2, p. 268.

merely a space excavated in the parenchyma of the spinal cord, and bounded only below by the cells of the endothelium belonging to the lower canal, the cells of the upper side having become gradually smaller, and eventually become non-existent, leaving the upper canal, as it proceeds forward, with only a slight lining of connective tissue.

At the posterior end of the medulla oblongata, the canal which is unprovided with endothelium becomes very much enlarged, and a smaller canal appears suddenly above it, which projects into the floor of the fossa rhomboidalis, and contains the central rod (fig. 7). The larger canal on reaching the base of the fissure on the dorsal surface between the anterior end of the medulla oblongata, and the posterior end of the corpora bigemina, passes downward and forward in a curved direction, and immediately beneath the posterior end of the posterior tuberosity of the brain, enlarges into a quadrangular or rounded chamber (fig. 2), the whole looking like a pipebowl and its stem. Two passages emerge from the upper wall of this chamber, one of these is directed upward and the other forward; both these passages are lined by endothelium, while the chamber from which they emerge is devoid of it.

These passages correspond evidently with the aqueduct of SYLVIUS and the ventricle of the corpora bigemina respectively; the horizontal canal ends abruptly at the anterior end of the corpora bigemina, but a distinct trace, without a lumen, is visible, leading forward and upward to the dorsal surface at the anterior end of the tubercula intermedia. This probably indicates the former course of the aqueduct of SYLVIUS.

The central rod comes forward from that part of the central canal which is situated in the spinal cord, and passing into the enlarged canal in the medulla oblongata, there divides into two parts, one part goes straight forward in the small upper canal before-mentioned on the floor of the sinus rhomboidalis, the other passes through the enlarged canal into the quadrangular chamber, and there forming a knot, goes upward, and is lost in the aqueduct of SYLVIUS.

There is no communication between the aqueduct of SYLVIUS and the third ventricle, which is almost entirely obliterated, the lower half corresponding to the infundibulum, being the only part that remains pervious; it forms a chamber immediately above the pituitary body or hypophysis, but separated from it by a membranous partition. The infundibulum (figs. 2 and 3, *inf.*) forms a thin walled sac attached to the base of the brain, and from its summit a fissure passes upward for about one third of the distance to the lower point of the ganglion habenulæ in the centre of the tubercula intermedia; the walls of the chamber are not nervous but endothelial, and there are no nerves to be seen supplying the hypophysis.

As has been before mentioned, the spinal cord begins behind by a narrow thread consisting only of endothelial cells and the central canal. This cannot be called a filium terminale, since it is not attached to anything.

The shape of a transverse section of the spinal cord in the central part of the body is that of a roof-tile or of an open book placed with its face downward. The dorsal edge is convex, and the ventral edge in the mid line is concave, while the contour on each side slightly swells out.

The grey matter consists of two flat lamellæ extending on each side the central canal. Cells of various sizes are present in the grey matter; some of the larger cells are fusiform in shape, others are multipolar; they occur along the ventral side and at the external edge of the grey matter, but no cells exist at the extreme lateral edge of the cord, separated from the grey matter by a space, as is the case in *Petromyzon*, according to REISSNER.* Cells of a smaller size occur on the dorsal edge and inner side of the grey matter. In passing forward into the medulla oblongata, the grey matter gradually changes in shape from the narrow lamellar formation mentioned above into a shape resembling the wing of a butterfly (fig. 9), at the same time small nuclei, resembling those found farther forward, are substituted for the large multipolar or or bipolar cells. The former gradually disperse over the whole field until the arrangement found in the anterior part of the brain is attained.

The Müllerian fibres of *Myxine* resemble those of *Petromyzon* in appearance, but are much smaller, the largest being only 0·015 millims. in diameter, while those of the latter range up to 0·05 millims. in their longest diameter, being generally oval in contour; those of *Myxine* are usually circular. In *Petromyzon* there is an abrupt difference in size between the large fibres composing the ventral bundles, and those smaller ones which occupy the remainder of the section; but in *Myxine* there is a regular gradation between the largest and the smallest.

A group (fig. 9 *v.l.c.*) of the largest-sized fibres is found on each side of the mid-line beneath the ventral edge of the grey matter, they correspond in position to the inner group of Müllerian fibres in *Petromyzon*. (These were, as is well known, discovered by JOHANNES MÜLLER and so named by OWSJANNIKOW.†) They correspond also to the ventral columns in *Teleostei* and *Elasmobranchii*, in addition to these well-defined bundles, fibres also of large size are found scattered along the ventral edge, the external end, and partly along the dorsal edge of the cord; the only part where they are not found is on the dorsal side for some distance on each side of the mid-line, which space is occupied by fibres of the finest calibre, but fibres of this size are found in all parts of the cord filling the spaces between those of the larger size; as in *Petromyzon*, none of these fibres are provided with a medullary sheath.

I have not succeeded with certainty in finding any transverse commissures in the spinal cord. In the mid-line ventrad of the central canal there is a decussation of fibres, which at first I took for nerve fibres, but further inspection showed that they belong to the raphe, and are neuroglia fibrils, which come out of the grey matter of one side, and are attached to the sheath of the spinal cord on the other. Nevertheless, NANSEN,‡ by means of GOLGI's chromo-silver method, demonstrated that there are true commissural fibres among these.

* No. 102. † No. 92. ‡ No. 268, fig. 107.

In a transverse section of the spinal cord three longitudinal columns can be recognized in the white matter; these may be termed the ventral, lateral, and dorsal columns. The corresponding columns in *Petromyzon* were termed by AHLBORN funiculus ventralis, lateralis, and dorsalis. The ventral column contains a few fibres of the largest size, together with many that are much smaller; although these fibres are larger than any others occurring in the spinal cord of *Myxine*, they by no means equal the Müllerian fibres in the corresponding columns of *Petromyzon* in size, as was before mentioned, nor do they appear so conspicuous in section. The neuroglian framework in which these fibres are imbedded probably answers the same purpose as the medullary sheath. I have not seen these Müllerian fibres break up into fibrils, as is stated to be the case by OWSJANNIKÔW, who says that he has found that they divide in *Petromyzon* into fine branches, two of which were connected with small cells. This observation has not been confirmed, and is, in fact, contrary to the result of AHLBORN'S work.

The ventral columns are traceable as far forward as the fissure on the dorsal side of the brain, which separates the anterior end of the medulla oblongata from the posterior end of the corpora bigemina; here the external fibres of this column decussate with those of the other side, in company with a large decussation of fibres to be mentioned farther on; the remaining fibres of the ventral column pass forward on the same side on which they were originally situated, and are lost in the parenchyma beneath the aqueduct of Sylvius.

The lateral columns consist of fibres which, though smaller than those of the ventral columns, are larger than those which occupy the spaces between the Müllerian fibres, both here and in the ventral columns. They do not decussate as some of the fibres of the ventral column do, but can be traced forward as far as the central ganglion, where, as a recognizable column, they become lost and are dispersed, but isolated fibres can be traced farther forward. This arrangement seems to correspond to that found in *Petromyzon*, as described by AHLBORN.*

The dorsal columns consist entirely of fibres of the smallest calibre.

Medulla Oblongata.

The medulla oblongata is the largest and most conspicuous segment of the brain; in it are to be found two pairs of remarkable ganglia, which contain cells of the largest size found in the nervous system of *Myxine*. A pair of these ganglia (figs. 2 and 7, *c.g.*) are situated one on each side the mid-line; they may be termed the central ganglia. They contain cells of very large size, and also others which are smaller. The shape of these cells varies; some are triangular and broad, others are elongated and narrow. The larger ones vary in length from 0·05 millim. to 0·07 millim., and from 0·033 millim. to 0·05 millim. in width. The smaller cells belonging to this

* No. 246.

ganglion vary from 0·03 millim. to 0·05 millim. in length, and from 0·02 millim. to 0·022 millim. in width. The size of the nuclei of the latter cells did not invariably diminish in like proportion.

The other pair of ganglia (figs. 6, 7, and 8, *l.v.g.*) are situated near the outer edge of the medulla oblongata, toward the ventral side, and may be termed the latero-ventral ganglion; they probably correspond to the nucleus of the olivary bodies in position, though the origin of the facial and vagus from it seems to preclude this idea. It is to be presumed that Dr. A. RETZIUS* was not referring to this ganglion when he claimed to have found the olivary bodies in the medulla oblongata of this animal, as he does not mention the occurrence of cells. In the frog, however, KÖPPEN† mentions a ganglion occupying a position corresponding to this nucleus—the oliva inferior, as it is termed by EDINGER.‡

The cells of these ganglia correspond in size to the smaller cells of the central ganglia; they vary in length from 0·037 millim. to 0·053 millim., and from 0·017 millim. to 0·034 millim. in width. The tripolar and multipolar cells predominate, but many are bipolar.

These latero-ventral ganglia (fig. 8, *l.v.g.*) extend along the lateral margin of the medulla oblongata on each side, from the entrance of the trigeminus in front to that of the vagus behind, in one continuous column of cells of various thickness. Anteriorly, each one makes a bend upward, and forms a collection of cells which are larger than those of the remainder of the ganglion; then, as a thinner line of smaller cells, extends backward, and terminates behind in a wide and elongated group of small cells, projecting slightly toward the dorsal surface.

Anterior to these ganglia, beneath the aqueduct of SYLVIUS, but still in the part which, according to AHLBORN, belongs to the medulla oblongata, there is another pair of ganglia, situated at a point corresponding to the position occupied in other vertebrates by the oculo-motor ganglia, and also to the position in which three gigantic cells are to be found in *Petromyzon*. These groups of cells may be termed the anterior ganglia. The cells here are of unusual size for *Myxine*, but do not equal the largest that are to be found in the central ganglia; their length ranges from 0·04 millim. to 0·06 millim., and their breadth from 0·028 millim. to 0·053 millim. These cells are of the same description as those occurring in the central and latero-ventral ganglia. The three gigantic cells in *Petromyzon*, which are situated beneath the aqueduct of SYLVIUS, and measure as much as 0·1 millim. in length and nearly as much in width, are represented in *Myxine* by the above-mentioned anterior ganglion, composed of smaller but more numerous cells.

The central ganglia correspond to the ganglia on the floor of the fourth ventricle in *Petromyzon*; but the latero-ventral ganglia do not seem to have any homology in that animal.

* No. 23. † No. 317.

‡ 'Zwölf Vorlesungen ü. d. Bau der nervösen Centralorgane,' 1892, p. 150.

In *Myxine* there is a large decussation of fibres connected with the central ganglia, which resembles a fountain in shape; this decussation connects the ventral cells of the central ganglion of one side, with the dorso-lateral region beneath the upper exit of the acusticus root on the other. Its greatest development is coincident with that of the central ganglia; it is visible as far as the posterior end of the medulla oblongata as a feeble development, and it is continuous with the raphe in the spinal cord, which contains decussating fibres also, but these are nothing more than neuroglia fibrils. Anteriorly this decussation extends in a diminished size beneath the posterior end of the corpora bigemina, where the cerebellum would be if it existed, and then gradually disappears. Many of the cells of the central ganglia send processes to accompany the fibres of this decussation, so that they evidently belong to it. In the case of the multipolar cells, only one of the processes joins the fibres; but in the case of the bipolar cells, both processes, one from each end of the cell, join; one process going toward the dorsal, the other toward the ventral, side of the section.

As before mentioned, the external fibres of the ventral longitudinal column from the spinal cord decussate here, and join the fibres of this decussation, being lost with them in the dorso-lateral portions of the section. They are distinguished from the proper fibres of the decussation by their larger size. I could not make out which nerve-root they joined, if any, or if they behaved as the corresponding fibres in *Petromyzon*, which, according to the schematic figure of AHLBORN* join the facial acusticus roots.

Cranial Nerves.

First Nerve (fig. 2).—The fibres of the olfactory nerve pass out from the whole depth of the front edge of the olfactory lobe, forming one large trunk and four smaller ones; the former arises from the dorsal edge of each lobe, and the latter come from the external margin, they pass upward, and joining the large trunk, unite into a nerve on each side, which, passing forward along the dorsal wall of the olfactory sac, give off bundles of fibrils at intervals, which pass down into the lamellæ attached to the dorsal wall.

Second Nerve.—This animal is totally blind, but there are indications of a pair of degenerate eyes (fig. 15) deeply buried beneath the lateral muscular mass, and placed close to the external wall of the olfactory sac. Each consists of a small chamber surrounded by a circular thickened parietes; on the external side, where this is thinner, it is united together by a suture. In parts of the thickness of the walls there is a striated appearance which looks as if it were the remains of the retina. This body is enclosed in a thin membranous shut sac; the whole surrounded by a thick membrane which is continuous with the sheath of the upper branch of the trifacial nerve.

There is not much here to recall the structure of the eye, but its position and the

* No. 238.

constancy of its occurrence seem to indicate that that is the proper interpretation of this body. Moreover J. MÜLLER* described a body on the corresponding position in this species, which he explained as a degenerate eye. He also gave a figure of a body found in a corresponding position in *Bdellostoma,* which was better developed and more superficially placed, in which he also found indications of a fine nerve. In the body which I have just described no indications of a nerve were present.

The eyes being thus imperfect, it is not surprising that the optic nerve is equally so ; a trace of its existence, however, is still to be found ; on the inferior surface of the brain there is visible on each side a minute thread of connective tissue (fig. 2), in which a few nerve fibres are found ; which extends from a point immediately in front of the thalamencephalon to the internal surface of the skull, where it becomes merged in the connective tissue lining the same ; at the point where these threads join the brain there is a sort of confused vortex of fibres which looks as if it might possibly be the remains of a chiasma. As these threads occupy a position corresponding to the place where the optic nerves would be found, if in existence, it seems very probable that they are the degenerated remains of that nerve. In *Bdellostoma,* according to J. MÜLLER,† they are comparatively well developed.

The same circumstances which conditioned the loss of the optic nerves, applied also to the nerves supplying the ocular muscles, which have left no trace behind.

It is superfluous to go minutely into the distribution of the cranial nerves, as they are shown in a masterly manner by J. MÜLLER,‡ I shall therefore merely give a slight outline of their course without going into detail.

Fifth Nerve.—The Trifacial arises by one root only (fig. 6), from the anterior end of the lateral tuberosities of the medulla oblongata, which homologize with the restiform bodies. The fibres of this root pass backward in the medulla oblongata, outside and above the latero-ventral ganglion ; these fibres cannot be traced into the lateral column of the spinal cord, but disappear from view in close proximity to them. This root corresponds to the ascending root in higher vertebrata. I could find no other.

The trifacial passes out of the skull through a distinct foramen, and immediately joins a large collection of cells, which corresponds to the Gasserian ganglion. This ganglion is elongated from behind forward, and its cells extend for some distance into the trunks which emerge from it. Two large nerve branches pass forward from this ganglion ; an upper division which emerges from the anterior and lower edge of the ganglion, and passes along the dorsal side of the trabeculum, and a lower division which emerges from the lower edge immediately behind the last, and follows a course downward and forward beneath the above-mentioned rod.

The distribution shortly is as follows : the upper or dorsal branch, after emerging from the Gasserian ganglion and piercing the membrane or aponeurosis which connects the upper edge of the trabeculum with the side of the skull, divides into two branches,

* No. 41. † No. 41, Tab. II, fig. 9.
‡ No. 48 ; also No. 47, Tab. VIII, figs. 1 and 2.

an upper and a lower; these ultimately supply the skin of the upper lip. Immediately after emerging from the anterior end of the ganglion, while still some cells are seen in the interior of the nerve-trunk, this division gives off a branch which passes nearly in a direction outward to supply the skin on the outer side of the head, also a branch going directly upward to the skin on the dorsal side. The lower division of the trifacial is traceable along the side of the œsophagus and ends in a peculiar glandular structure attached to that tube.

Seventh Nerve (fig. 6).—The facial arises by one root from the side of the medulla oblongata, behind and below the origin of the trifacial. Its fibres are derived from the anterior end of the latero-ventral ganglion by several bundles, the more anterior pass through the anterior clump of larger cells—these I could not find the end of; but the posterior fasciculi pass obliquely backward and inward into that part of the latero-ventral ganglion containing smaller cells lying behind the above-mentioned clump of larger cells. The processes of some of these cells, which are mostly bipolar, are traceable into these bundles of fibres of the facial root. The nerve passes forward beneath the Gasserian ganglion without communicating, and eventually supplies the skin at the inferior side of the lip and also the inferior feeler.

In *Petromyzon* RANSOM and THOMPSON* describe a ganglion at the root of the facial; in *Myxine* I have not been able to discover one, but the whole arrangement in *Myxine* is so abnormal, if one may use the expression, that this is not surprising. Both these authors and AHLBORN describe a branch from the facial in *Petromyzon*, which goes round the outer side of the ear capsule to join the vagus; this is not the case in *Myxine*, but a corresponding connection between the facial and the vagus is found in *Ceratodus*;† this interesting fact might throw some light on the affinities of *Petromyzon* and seems to support the theory put forward by Dr. BEARD‡ that the *Cyclostomata* and the *Ganoids* are more closely related than hitherto supposed.

Dr. GÜNTHER § calls the Dipnoi a sub-order of the order Ganoidei, of which Polypterus, Lepidosteus, &c., are also sub-orders.

Eighth Nerve.—The acusticus (figs. 7 and 8) arises by two or more roots; immediately on passing out of the cord these roots join a ganglion which is placed vertically in juxtaposition to the lateral edge of the medulla; of the two roots, the dorsal one arises in the dorsal region of the medulla oblongata, the fibres pass in a curved direction, first upward then outwards, and join the dorsal end of the ganglion; the fibres of the central decussation are not continuous with them, but a continuation of the curved course of the former would tend rather to cross them at nearly right angles. This part corresponds to the origin of the acusticus in *Petromyzon*, in which animal, according to ROHON,|| it derives its whole root exclusively from the dorso-lateral part of the medulla. ROHON is agreed with OWSJANNIKOW as to the origin of this nerve, but according to the former, the processes of the large cells on the

* No. 272. † Nos. 208 and 339. ‡ No. 342.

§ "The Study of Fishes," 1880. || No. 232.

floor of the fourth ventricle join acusticus, whereas the latter* maintains that they join the facial.

The ventral root, which does not appear to be represented in *Petromyzon*, is composed of two or more bundles, which join the external ganglion at its ventral edge. Its fibres pass through the central part of the latero-ventral ganglion; some of the fibres certainly are derived therefrom, but many can be traced through and beyond them. In some specimens, in addition to these two roots, others emerge from the side of the medulla oblongata to join the lateral margin of the ganglion. The whole ganglion is situated immediately behind the entrance of the facial nerve. The trunk of the acusticus emerges from the posterior end of the ganglion, and passes backward and downward as a large nerve; arrived at the posterior end of the auditory apparatus, it enters between the ear capsule and the membranous labyrinth (fig. 8).

Tenth Nerve.—It seems very difficult to determine the number of roots belonging to the vagus in *Petromyzon*. All the writers on this subject differ: RATHKE† gives three roots; SCHLEMM and D'ALTON‡ mention only two, the united trunk of which they say is joined by the facial; AHLBORN§ alleges eight, RANSOM and THOMPSON|| four, SHORE¶ and SCHNEIDER** also four. Whatever may be the case in *Petromyzon*, I have not been able to find more than one root to the vagus in *Myxine* (fig. 8); this is divided into three bundles, which come out from the medulla oblongata vertically from above downward; they emerge from the extreme posterior end of the latero-ventral ganglion; they unite into one nerve-trunk, which passes over the ear capsule and pursues its course backward between the dorsal and ventral muscular masses, and is therefore the lateral nerve.

From the dorsal side of the extreme posterior end of the same latero-ventral ganglion there arises a very small root (fig. 8), which immediately passes upward and backward, and joins a ganglion which resembles a spinal ganglion in appearance. This ganglion is situated in the vertebral canal, close to the point where the medulla oblongata contracts in diameter to pass gradually into the spinal cord. This, perhaps, may be looked upon as a dorsal root belonging to the vagus.

A short distance farther back, another nerve (fig. 9) is found, arising by a dorsal and ventral root from the transition part of the medulla oblongata, at the place where the grey matter begins to change from the lamella-like form in the spinal cord into the more expanded form at the posterior end of the medulla oblongata. The dorsal root which emerges from the dorsal side of the medulla oblongata by a conical insertion like the dorsal roots of the spinal nerves, is traceable into the dorsal horn of grey matter, and the ventral is traceable into the ventral horn; they each pass out through a separate foramen, and join the posterior part of the same ganglion to which the above-mentioned dorsal root of the vagus is attached. It is just possible that this

* No. 114. † No. 29. ‡ No. 43. § No. 247.
|| No. 272. ¶ No. 322. ** No. 191.

may correspond to the root in *Petromyzon*, which SCHLEMM and D'ALTON* considered to be the hypoglossal; but I think it more probable that in this case it is part of the vagus, but the question is rather obscure, the nerve being so minute, and its further course not being visible.

The nerves which are absent from the *Myxine* are the oculomotorius, trochlearis, abducens, glossopharyngeal, and if the above considerations are correct, the hypoglossal.

Fresh material is necessary to elucidate the question as to the vagus.

Spinal Nerves.

The spinal nerves are arranged alternately on the two sides, thus; proceeding from behind forward, we come first to a dorsal root, then to a spinal ganglion, then to a ventral root; after that the same arrangement begins on the other side, and so on, first on one side and then on the other; occasionally, but very seldom, it occurs that the dorsal roots are placed opposite each other, and in one case a dorsal root was missing, so that two roots occurred consecutively on the same side, without one on the other side. This arrangement corresponds to that of the spinal nerve roots in Ammocætes according to FREUD,† at least as far as the alternating dorsal and ventral roots are concerned. This author, as well as others, uses the terms and anterior and posterior as applied to the roots of the spinal nerves, terms which are only applicable to human anatomy, and are inappropriate when applied to animals which never progress in an erect position. In *Amphioxus* also, according to BALFOUR,‡ the spinal nerves come off alternately on each side, although they only have dorsal roots, the principle is the same in all, indicating their embryonic position.

The dorsal root (fig. 11) arises by one compact bundle, like the arrangement described by FREUD in *Petromyzon*. It is inserted into the dorsal edge of the spinal cord like a peg by a conical progress; from this the fibres spread out in a fan-like manner and reach the dorsal edge of the grey matter by an oblique course not far from the midline, but to the outer side of a little eminence of the grey matter containing small cells. The position of the entrance of the dorsal root into the cord is about half of the distance between the external edge and the central canal. According to FREUD§ the dorsal root in *Petromyzon* arises from a large cell, by his figure one would say gigantic; but in *Myxine* there are no large cells anywhere near the origin of this root, and it most probably arises from small cells. Between the spinal cord and the wall of the vertebral canal, the dorsal root is folded once or twice, then it passes through a separate foramen and immediately joins the spinal ganglion near its dorsal end. This ganglion inclines from the dorsal side ventrad and forward; its upper end is usually club-shaped in section, and its lower end is generally pointed,

* No. 43. † No. 169. ‡ No. 156. § No. 169.

and terminates in a nerve trunk, which after a short course is joined at an acute angle by the ventral root.

The ventral root (fig. 10) in *Myxine* arises from the cord by three or four consecutive bundles, which join into one while passing out of the vertebral canal through a foramen distinct from that through which the dorsal root emerges, or just outside it. They also have a somewhat contorted course in the vertebral canal before emerging from the ventral external angle of the canal.

The spinal ganglia are composed of bipolar cells of various sizes.

Two nerves are given off from the spinal ganglion. The dorsal ramus proceeds from the summit of the ganglion in nearly a straight line toward the dorsal surface of the body, and passing through the fold of connective tissue, which, like a mesentery connects the skin to the muscles of the back, supplies the integument of the dorsal side of the body. It is to be noticed that this branch is given off without the participation of the ventral root, fibres from the dorsal root alone being present in it. An arrangement corresponding to this is described by GOETTE* as occurring in *Petromyzon*, in which also the dorsal ramus is given off from the dorsal edge of the ganglion without being joined by the ventral root.

The ventral ramus, however, which proceeds from the ventral or lower pointed end of the ganglion, is the combined result of the ventral root and fibres from the ganglion, and passes outside the peritoneal cavity to supply the ventral side of the body, and also the lateral muscles.

The ganglion belonging to the last of the spinal roots gives off a branch which goes back, outside the vertebral canal above the level of the spinal cord. On this two successive ganglia are developed on each side, which have no corresponding spinal roots. After the second ganglion this branch breaks up into a terminal pencil of nerve-fibres, which supply the extreme end of the tail; but sometimes this terminal brush is given off in front of the two ganglia, instead of behind them, in which case they are developed, not on the main trunk, but on one of the terminal threads.

CONCLUSION.

The question of degeneracy appears to divide biologists into two camps, some, as DOHRN or LANKESTER, would find degeneracy where MILNES MARSHALL finds none.

Myxine is a particular case of a general idea, and the brain of *Myxine* a still more particular idea; and now the question arises: Is the brain of *Myxine* degenerate or not? With regard to one part the answer would be in the negative; with regard to another part it would be in the affirmative. The olfactory lobes are as well, if not better, developed than in the *Teleostei*; the glomeruli are more distinct than in these, but not more so than in *Elasmobranchii*; on the other hand, the cerebrum and the corpora bigemina are small, and, compared to the corresponding bodies in *Teleostei*,

* No. 310.

their structure is simple. The tubercula intermedia are large in comparison with those of the *Teleostei* and *Elasmobranchii*, which is a point in favour of *Myxine;* but then the cerebellum is entirely absent. Thus, on the whole, the brain of *Myxine* may be considered as decidedly of a low type, that is to say, degenerate.

Professor MILNES MARSHALL remarks that we might as well call human beings degenerate because some part of their anatomy is so in comparison to other animals; but whether, when so important an organ as the brain is degenerate, we can argue as to the degeneracy of the whole body, is perhaps another matter. At any rate the conclusion to which I come, is that, judging from the nervous system, *Myxine* is an offshoot and is not in the main phylon of the vetebrata.

Myxine appears to present the only instance in the vertebrate kingdom of the entire absence of an important section of the brain, viz., the cerebellum. This deficiency is proved not only by the non-existence of Purkinge cells and the characteristic molecular, granular, and medullary layers, but also by the fact that the restiform bodies end free in front, and do not join, as they do in all other cases, any of the tuberosities of the brain. Purkinge cells are so characteristic of the cerebellum, that even in animals in which it is reduced to the smallest dimensions, as in *Amphibia*, *Ceratodus*, &c., these cells are still found. As they are present in *Ceratodus*, so I should have presumed that they would have been found in its nearest ally the *Protopterus annecteus*, but Dr. R. BURCKHARDT,* the most recent writer on the brain of this animal, did not succeed in finding them.

The general idea as to the function of the cerebellum appears† formerly to have been, that it serves to coordinate muscular action, but recent experiments where the animal operated on recovered that faculty after a time, and also the occurrence of cases where the cerebellum had been destroyed by disease, without the fact having been suspected during life,‡ has rather thrown discredit on this theory. FERRIER§ assigns the faculty of equilibration to this organ. Altogether its function seems still to remain in doubt, and probably whatever it may be it is capable of being exercised by other parts of the brain ; and here in *Myxine* we have, as it were, a natural experiment to show that some animals can get on very well without any cerebellum whatever.

EXPLANATION OF PLATES.

Fig. 1.—Dorsal aspect of the brain. × 6.

Fig. 2.—A sagittal section of the brain, close to the mid line ; it is composed of more than one section : the cells and the optic nerve being thus placed nearer the central line than they would be naturally. × 25. The figures, con-

* No. 377.

† FLOURENS, P., 'Recherches expérimentales sur les propriétés et les fonctions du système nerveux,' Paris, 1824.

‡ MAGENDIE M., 'Leçons sur les fonctions et les maladies du système nerveux,' Paris, 1839.

§ 'The Functions of the Brain,' 1886.

nected by a line, which are placed above and below this section, indicate the position of the transverse sections of the same numbers.

Fig. 3.—Transverse section through the tubercula intermedia and the infundibulum. × 25.

Fig. 4.—Transverse section farther back, through the corpora bigemina and aqueduct of SYLVIUS. × 25.

Fig. 5.—Transverse section through the corpora bigemina behind last. × 25.

Fig. 6.—Transverse section through the anterior end of the medulla oblongata, behind the last. × 42.

Fig. 7.—Transverse section through the medulla oblongata, behind the last. × 42.

Fig. 8.—Sagittal section through the outer side of the medulla oblongata. × 42.

Fig. 9.—Transverse section through the posterior end of the medulla oblongata. × 42.

Fig. 10.—Transverse section through the spinal cord, near the middle of the body, showing ventral root of spinal nerve. × 200.

Fig. 11.—Transverse section through the middle part of the spinal cord to show dorsal root. × 200.

Fig. 12.—Transverse section through the dorsal part of the cerebrum. × 200.

Fig. 13.—Transverse section through the ganglion habenulæ. × 340.

Fig. 14.—Cells from various portions of the brain. × 700.

a, *b*, *f*, *g*.—Cells from the olfactory lobe.

e.—Cell from between olfactory lobe and the cerebrum.

c.h.—Cells from the cerebrum.

d.i.—Cells from the corpora bigemina.

Fig. 15.—Transverse section of the degenerate eye and the neighbouring parts. × 42.

V.—Upper branch of the trifacial.

All letters have the same signification throughout.

a.c. Auditory capsule.
a.g. Anterior ganglion.
aq. Aqueduct of SYLVIUS.
b.v. Blood vessels.
c.bi. Corpora bigemina.
c.c. Central canal.
c.d. Central decussation.
ce. Cerebrum.
c.g. Central ganglion.
ch. Chorda dorsalis.
c.pl. Choroid plexus.
c.r. Central rod.
c.rest. Corpora restiformia.
d.m. Dura mater.
d.r. Dorsal root.
g.h. Ganglion habenulæ.
g.i. Ganglion interpedunculare.
g.m. Grey matter.
g. VIII. Ganglion of the acusticus.
g. X. Ganglion of the vagus.
hy. Hypophysis.
inf. Infundibulum.
l. Part of the membranous labyrinth.

l.c Lateral columns.
l.v.g. Lateral-ventral ganglion.
m.b. MEYNERT's bundles.
m.o. Medulla oblongata.
ol.l. Olfactory lobe.
ol.sac. Olfactory sac.
o.m. Old mouth (Beard)?
p.m. Pia mater.
sp. Spinal cord.
s.r. Sinus rhomboidalis.
t.i. Tubercula intermedia.
tr. Trabeculum.
v.c.bi. Ventricle of the corpora bigemina.
v.l.c. Ventral longitudinal columns.
v.r. Ventral root.
w.m. White matter.
I. Olfactory nerve.
II. Optic nerve.
V. Trifacial.
VII. Facial.
VIII. Acusticus.
X. Vagus.

LIST OF PUBLICATIONS RELATING TO THE NERVOUS SYSTEM OF ICHTHYOPSIDA.

*Papers marked thus * are only known through quotations.*

(1.) 1664. MALPIGHII, MARCELLI. De cerbro epistolæ ad Carolum Fracassatum.
(2.) 1664. WILLIS, THOMÆ. Cerebri Anatome.
(3.) 1678. LORENZINI, STEFANO. Osservazioni intorno alle Torpedini. Firenze.
(4.) 1681. BLASII, GERARDI. Anatome Animalium.
(5.) 1685. COLLINS, S. System of Comparative Anatomy.
(6.) 1757. HALLER, ALBERTI V. Elementa physiologiæ corporis Humani, tome ii, p. 591.
(7.) 1763. HALLER, ALBERTI V. Opera Minora, tome iii.
(8.) 1776. VICQ D'AZYR. Mém. de Mathématique et de Physique, tome vii. Paris.
(9.) 1785. CAMPER, P. Sämmtliche kleinere Schriften. Trans. into German by T. F. M. HERBELL.
(10.) 1785. MONRO, ALEX. Structure and Physiology of Fishes.
(11.) 1788. EBEL, GODFREDI. Observationes Neurologicæ.
(12.) 1814. CARUS, CARL GUSTAV. Versuch einer Darstellung des Nervensystems.
(13.) 1816. TIEDEMANN, F. Deutsches Archiv für die Physiologie, Bd. ii.
(14.) 1816. TIEDEMANN, F. Anatomie und Bildungsgeschichte des Gehirns im Fœtus des Menschen.
(15.) 1816. TREVIRANUS, G. R. und L. C. Vermischte Schriften, anatomische.
(16.) 1817. WEBER, ERNESTO HENRICO. Anatomia comparata nervi sympathetici. Lipsiæ.
(17.) 1817. WITTZACK, J. C. A. De piscium cerebro. Berolini.
(18.) 1818. JACOBSON, L. De quinto nervorum pari animalium. Regiomonti.
(19.) 1820. FENNER, C. W. H. De anatomia comparata, &c. Jenæ.
(20.) 1820. KUHL, HEINRICH. Beiträge zur Zoologie und vergleichenden Anatomie.

(21.) 1820. WEBERO, ERNESTO HENRICO. De Aure et Auditu hominis et animalium. Lipsiæ.

(23.) 1822. RETZIUS, Dr. A. Beitrag zu der Anatomie des Ader- und Nervensystems der Myxine glutinosa.

Abhandlungen der k. schwedischen Akademie der Wissenschaften; also

MECKEL's Archiv für Anatomie und Physiologie. 1826.

(24.) 1823. BAILLY, E. M. Recherches d'anatomie comparée du système nerveux, &c.

(25.) 1824. SOMMÉ, C. S. Recherches sur l'anatomie comparée du cerveau.

(26.) 1824. SERRES, E. R. A. Anatomie comparée du cerveau dans les quatres classes des animaux vertébrés.

(27.) 1825. DESMOULINS, A. Anatomie des systèmes nerveux des animaux vertébrés.

(28.) 1826. OTTO, Dr. A. W. Über die Gehörorgane des Lepidoloprus brachyrhynchus, &c. TIEDEMANN und TREVIRANUS. Zeitschrift für Physiologie. Bd. ii.

(29.) 1826. RATHKE, HEINRICH. Bemerkungen über den innern Bau der Pricke (Petromyzon fluviatilis) des Linneus. Danzig.

(30.) 1827. BORN, Dr. G. Ueber den innern Bau der Lamprete. Heusinger Zeitschrift für die organische Physik, Bd. i.

(31.) 1827. WEBER, ERNST HEINRICH. Ueber vier Langennerven bei einigen Fischen.

Ueber das Geschmacksorgan der Karpfen und den Ursprung seiner Nerven.

Knoten und unpaarer Faden, mit dem sich das Rückenmark bei einigen Fischen endigt.

Beim Häringe durchbohrt der Sehnerv des rechten Auges den des linken.

MECKEL's Archiv für Anatomie und Physiologie.

(32.) 1828. CUVIER et VALENCIENNES. Histoires naturelles des Poissons.

(33.) 1828. ROLANDO, LUIGI. Saggio sopra la vera struttura del cervello. Torino.

(34.) 1831. TREVIRANUS, G. R. Über die hintern Hemisphären des Gehirns der Vögel, Amphibien und Fische. TIEDEMANN und TREVIRANUS' Zeitschrift, Bd. iv.

(35.) 1833. GILTAY, CAROLI MARINI. Descriptio neurologica Esocis lucii. Annales Acad. Lugduno Bataviæ, tome xvii.

(36.) 1833. ZAGORSKY, ALEXANDER. De systemate nerveopiscium considerationes. Dorpati Livonorum.

(37.) 1835. BAER, KARL ERNST v. Untersuchungen über die Entwickelungsgeschichte der Fische; also, Entwickelungsgeschichte der Thiere, 1828 to 1837.

(38.) 1835. BÜCHNER, G. Mémoire sur le système nerveux du Barbeau (Cyprinus barbus). Mémoires de la Société d'Histoire Naturelles de Strasbourg, tome ii.

(39.) 1835. GÖTTSCHE. Vergleichende Anatomie des Gehirns der Grätenfische MÜLLER's Archiv für Anatomie und Physiologie.

(40.) 1836. ARSAKYI, APOSTOLI. Commentatio de piscium cerebro et medulla spinali.

(41.) 1838. MÜLLER, J. Ueber den eigenthümlichen Bau des Gehörorgans bei den Cyclostomes. Berlin.

(42.) 1838. RATHKE, H. Ueber die Entstehung der glandula pituitaria. MÜLLER's Archiv für Anatomie und Physiologie, Bd. v.

(43.) 1838. SCHLEMM und D'ALTON. Ueber das Nervensystem der Petromyzon. MÜLLER's Archiv für Anatomie und Physiologie.

(44.) 1838. VOLKMANN, Dr. A. W. Ueber die Faserung des Rückenmarks, &c., in Rana esculenta. MÜLLER's Archiv für Anatomie und Physiologie.

(45.) 1839. LEURET, FR. et GRATIOLET. Système nerveux.

(46.) 1839. MÜLLER, JOHANNES. Ueber den Amphioxus lanceolatus. Ber. Ver. k. Preuss. Akad. d. Wiss., Berlin.

(47.) 1840. MÜLLER, JOHANNES. Vergleichende Anatomie der Myxinoiden.

(48.) 1840. MÜLLER, J. Vergleichende Neurologie der Myxinoiden.

(49.) 1841. GOODSIR. On the Anatomy of Amphioxus lanceolatus. Trans. Roy. Soc., Edin., vol. xv.

(50.) 1841. MÜLLER, J. Ueber den Amphioxus lanceolatus. Ber. Ver. k. Preuss. Akad. d. Wiss., Berlin.

(51.) 1841. RATHKE, HEINRICH. Bemerkungen über den Bau des Amphioxus lanceolatus. Königsberg.

(52.) 1842. LONGET, F. A. Anatomie et Physiologie du système nerveux de l'homme et des animaux vertébrés. Paris.

(53.) 1842. STANNIUS, H. Peripherisches Nervensystem des Dorsch (Gadus callarias). Archiv für Anatomie.

(54.) 1842. VALENTINE, G. Beiträge zur Anatomie des Zitteraales (Gymnotus electricus). Neue Denkschriften der Allgemeinen Schweizerischen Gesellschaft, Bd. vi. Also published separately.

(55.) 1842. VALENTINE, G. Ueber das centrale Nervensystem, &c., der Chimæra monstrosa. Archiv für Anatomie.

(56.) 1842. VOGT, C. Embryologie des Salmones, in Histoires Naturelles des Poissons d'eau douce, par L. AGASSIZ.

(57.) 1843. FISCHER, Dr. J. G. Amphibiorum nudorum neurologia. Berolini.

(58.) 1843. GUILLOT, NATALIS. Exposition anat. du centre nerveux, &c. Mém. Cour. de l'Académie Royale de Bruxelles, tome xvi.

(59.) 1843. Kölliker, Dr. Ueber das Geruchsorgan von Amphioxus. Archiv für Anatomie.

(60.) 1843. Stannius, Prof. Dr. Bau des Gehirns des Stors. Archiv für Anatomie.

(61.) 1844. Budge, Dr. Julius. Ueber den Verlauf der Nervenfasern im Rückenmark des Frosches. Archiv für Anatomie.

(62.) 1844. Matteucci, C. Traité des Phénomènes électro-physiologiques des animaux—suivi des études anatomiques sur le système nerveux, &c. par Paul Savi. Paris.

(63.) 1845. Girgensohn, O. G. L. Anatomie und Physiologie des Fischnervensystems. Mémoires des Savants étrangers, St. Pétersbourg, tome v.

(64.) 1845. Hyrtl, Dr. Joseph. Lepidosiren paradoxa. Prag.

(65.) 1845. Quatrefages, M. A. de. Mémoires sur le système nerveux et sur l'histologie du Branchiostome ou Amphioxus. Annales des Sciences Naturelles, troisième série, tome 4.

(66.) 1846. Erdl. Über das Gehirn der Fischgattung Mormyrus. Gel. Anzeig., herausgegeben von Mitgl. der k. Bayer. Akad. d. Wiss., Bd. 23.

(67.) 1846. Harless, Dr. E. Briefliche Mittheilungen über die Ganglien-Kugeln der Lobi electrici von Torpedo galvani. Archiv für Anatomie.

(68.) 1846. Müller, Johannes. Ueber den Bau und die Grenzen der Ganoiden. Berlin.

(69.) 1847. Bidder, Dr. F. H. Zur Lehre von dem Verhältniss der Ganglien-Körper zu den Nervenfasern. Leipzig.

(70.) 1847. Franque, Henricus. Nonnulla ad Amiam calvam. Berolini.

(71.) 1847. Robin, Dr. Ch. Sur un appareil qui se trouve sur les poissons du genre des Raies, et qui présente les caractères anatomiques des organes électriques. Annales des Sciences Naturelles, troisième série, tome 7.

(72.) 1847. Wagner, R. Neue Untersuchungen über den Bau und die Endigung der Nerven und die Struktur der Ganglien. Supplement zu den Icones physiologicæ. Leipzig.

(73.) 1848. Busch, Guilelmus. De Selachiorum et Ganoideorum Encephalo. Berolini.

(74.) 1849. Stannius, Herm. Das peripherische Nervensystem der Fische. Rostock.

(75.) 1850. Blattmann, Dr. Alphonse. Mik. anat. Darstellung der Centralorgane des Nervensystems bei den Batrachiern. Zürich. Fr. Schulthess.

(76.) 1850. Klaatsch, H. M. A. De Cerebris Piscium. Halis.

(77.) 1850–1851. Wagner, Prof. Rudolf. Göttinger Nachrichten.

(78.) 1851. Leydig, Dr. F. Zur Anatomie und Histologie der Chimæra monstrosa. Archiv für Anatomie.

(79.) 1851. Stannius, Herm. Göttinger Nachrichten.

(80.) 1851. Wyman, Prof. Brain of Lumpfish. Proc. of the Boston Natural History Society, vol. iv.

(81.) 1852. Leydig, Fr. Beiträge zur mik. Anatomie der Rochen und Haie. Leipzig.

(82.) 1852. Philipeaux et Vulpian. Déterminations des parties qui constituent l'encéphale des Poissons. C. R., tome xxxiv.

(83.) 1852. Rathke, H. Bemerkuugen über mehrere Körpertheile der Cæcilia annulata. Archiv für Anatomie.

(84.) 1853. Axmann, Carl. Beiträge zur mik. Anatomie und Physiologie des Ganglien-Nervensystems. Berlin.

(85.) 1853. Marcusen, Johan. Sur quelques particularités des Mormyrus. Gaz. Médicales de Paris.

(86.) 1853. Philipeaux et Vulpian, MM. les Drs. Mémoires sur la structure de l'encéphale des Poissons cartilagineux. C. R., tome 37.

(87.) 1853. Wyman, Dr. J. Anatomy of the nervous system of the Rana pipiens. Smithsonian Contributions, vol. v.

(88.) 1854. Ecker, Alex. Anatomische Beschreibung des Gehirns vom karpfenartigen Nilhecht. Leipzig.

(89.) 1854. Jakubowitsch und Owsjannikow. Mikroscopische Untersuchungen. Bull. phys. math. de l'Acad. de St. Petersbourg, tome 14.

(90.) 1854. Marcusen, Johan. Vorläufige Mittheilungen über die Familie der Mormyren. Bull. de la Classe phys.-math. de l'Acad. Imp. des Sciences de St. Petersbourg, tome xii.

(91.) 1854. Remak, R. Ueber multipolar Ganglienzellen. Monatsberichte der k. Preuss. Akad. der Wiss. zu Berlin.

(92.) 1854. Owsjannikow, Philippus. Disquisitiones microscopicæ de Medulla spinalis textura imprimis in piscibus factitatæ. Dorpati Livonorum.

(93.) 1855. Remak, Robert. Untersuchungen über die Entwicklung der Wirbelthiere. Berlin.

(94.) 1857. Bidder, Dr. F. und Dr. C. Kupffer. Untersuchungen über die Textur des Rückenmarks. Leipzig.

(95.) 1857. Bilharz, Dr. Theodor. Das electrische Organ des Zitterwelses. Leipzig.

(96.) 1858. Kölliker, Prof. A. Vorläufige Mittheilungen über den Bau des Rückenmarks bei niederen Wirbelthieren. Zeitschrift für Wiss. Zoologie, Bd. 9.

(97.) 1858. Leuckart, Dr. Rud., und Dr. Alex. Pagenstecher. Untersuchungen über niedere Seethiere. Amphioxus lanceolatus. Archiv für Anatomie.

(98.) 1859. Mauthner, Lud. Untersuchungen über den Bau des Rückenmarks der Fische. Sitzungsberichte der k. Akad. der Wiss., Wien, Bd. xxxiv.

(99.) 1859. MAYER, F. L. C. Ueber den Bau des Gehirns der Fische. Verhandlungen der k. Leop. Car. Akad., Bd. xxx.

(100.) 1859. VIRCHOW, Prof. R. Die Cellular Pathologie. Berlin.

(101.) 1860. HOFFMANN, Dr. C. E. Beiträge zur Anatomie und Physiologie des Nervus vagus bei Fischen. Giessen.

(102.) 1860. REISSNER, E. Beiträge zur Kenntniss vom Bau des Rückenmarks von Petromyzon fluviatilis. Archiv für Anatomie.

(103.) 1861. RATHKE, HEINRICH. Entwicklungsgeschichte der Wirbelthiere. Leipzig.

(104.) 1861. STIEDA, LUDWIG. Ueber das Rückenmark und einzelne Theile des Gehirns vom Esox lucius. Dorpat.

(105.) 1863. BEALE, LIONEL S. On structure and formation of so-called unipolar and bipolar nerve cells of the frog. Phil. Transactions.

(106.) 1863. KUTSCHIN. Ueber den Bau des Rückenmarks des Neunauges. Kasan. Russian.

An abstract of this paper is given by STIEDA, "Referate aus der Russischen Literatur," Archiv für mik. Anatomie, Bd. ii, 1866.

(107.) 1863. SERRES, M. Recherches sur quelques points de l'organisation du Lepidosteus annecteus. C. R., tome 57. Paris.

(108.) 1864. BANDELOT, M. E. Recherches expérimentales sur les fonctions de l'encéphale des Poissons. Annales des Sciences Naturelles, 5e série, tome i.

(109.) 1864. DUMÉRIL, AUG. Histoires Naturelles des Poissons. Paris.

(110.) 1864. ECKER, Dr. ALEXANDER. Die Anatomie des Frosches. Mit. Beiträge von centralen Nervensystem, von Prof. R. WIEDERSHEIM. Braunschweig. VIEWEG.

(111.) 1864. FISCHER, Dr. J. G. Anatomische Abhandlungen über die Perennibranchiaten und Derotremen. Hamburg.

(112.) 1864. MARCUSEN, JOHANN. Die Familie Mormyren. Mémoires de l'Acad. Imp. des Sciences de St. Pétersbourg, viie série, tome vii.

(113.) 1864. MARCUSEN, M. J. Sur l'anatomie et l'histologie du Branchiostoma lubricum (COSTA). Amphioxus lanceolatus (YARREL). C. R., tome 58. Paris.

(114.) 1864. OWSJANNIKOW, PH. Ueber das Gehörorgan von Petromyzon fluviatilis. Mémoires de l'Acad. des Sciences de St. Pétersbourg, viie série, tome viii.

(115.) 1864. REISSNER, Dr. E. Der Bau des centralen Nervensystems der ungeschwänzten Batrachier. Dorpat.

(116.) 1864. SWAN, JOSEPH. Illustrations of the comparative anatomy of the nervous system. London.

(117.) 1865. DEITERS, OTTO. Untersuchungen über Gehirn und Rückenmark. Braunschweig.

(118.) 1865. HOLLARD. Recherches sur la structure de l'encéphale des Poissons. C. R., tome 60.

(119.) 1866. COURVOISIER, L. G. Beobachtungen über den sympathischen Granzstrang. Archiv für Mik. Anatomie, Bd. 2.

(120.) 1866. VULPIAN, A. Leçons sur la physiologie générale et comparée du système nerveux. Paris.

(121.) 1867. KOWALEVSKY. Entwicklung des Amphioxus. Mémoires de l'Acad. Imp. des Sciences de St. Pétersbourg, vii[e] série, tome xi.

(122.) 1867. OEFFINGER, H. Neue Untersuchungen über den Bau des Gehirns vom Nilhecht. Archiv für Anatomie.

(123.) 1868. CLARKE, LOCKHART. Researches into the intimate structure of the brain. Phil. Transactions, vol. 158.

(124.) 1868. COURVOISIER, L. G. Ueber die Zellen der Spinalganglien, sowie des sympathicus beim Frosch. Archiv für Mik. Anatomie, Bd. iv.

(125.) 1868. KUPFER. Beobachtungen über die Entwicklung der Knochenfische. Archiv für Mik. Anatomie, Bd. iv.

(126.) 1868. OWSJANNIKOW, PH. Ueber das Centralnervensystem des Amphioxus lanceolatus. Bull. de l'Acad. Imp. des Sciences. St. Pétersbourg, tome douzième.

(127.) 1868. SCHWALBE, DR. G. Ueber den Bau der Spinalganglien, &c. Archiv für Mik. Anatomie, Bd. iv.

(128.) 1868. STIEDA, DR. LUDWIG. Studien über das centrale Nervensystem der Knochenfische. Zeitschrift für Wiss. Zoologie, Bd. xviii. Separat-Abdruck.

(129.) 1870. BANDELOT, EMILE. Étude sur l'anatomie comparée de l'encéphale des Poissons. Mémoires de la Société des Sciences Naturelles de Strasbourg, Bd. vi.

(130.) 1870. GEGENBAUR, C. Grundzüge der vergleichenden Anatomie.

(131.) 1870. MIKLUCHO-MACLAY, N. VON. Beiträge zur vergleichenden Neurologie der Wirbelthiere. Leipzig.

(132.) 1870. STIEDA, LUDWIG. Studien über das centrale Nervensystem der Wirbelthiere. Zeitschrift für Wiss. Zoologie, Bd. xx. Separat-Abdruck.

(133.) 1871. GEGENBAUR, C. Ueber die Kopfnerven von Hexanthus. Jenaische Zeitschrift, Bd. 6.

(134.) 1871. MÜLLER, WILHELM. Ueber Entwicklung und Bau der Hypophysis cerebri. Jenaische Zeitschrift, Bd. 8.

(135.) 1871. SCHAPRINGER, ALOIS. Ueber die Bildung des Medullarrohres bei den Knochenfischen. Sitzungsberichte der k. Akademie der Wissenschaften, Wien, Bd. lxiv.

(136.) 1872. HUMPHRY, Prof. The muscles of Lepidosiren annectens with the cranial nerves. Journal of Anatomy and Physiology, vol. vi.

(137.) 1872. HUMPHRY, Prof. The muscles and nerves of the Cryptobranchus japonicus. Journal of Anatomy and Physiology, vol. vi.

(138.) 1872. KOLLMANN, Prof. Ueber den Kern der Ganglienzellen. Sitzungsberichte der math.-phys. Classe der k. baier. Akademie zu München.

(139.) 1872. WEIL, C. Entwicklung Teleost. Sitzungsberichte der k. Akad. der Wissenschaften, Wien, Bd. lxv.

(140.) 1872. WYMAN, J. Brain and spinal cord of Lumpfish. Memoirs of the Boston Natural History Society, vol. ii.

(141.) 1873. LANGERHANS, Dr. PAUL. Untersuchungen über Petromyzon planeri. Freiburg i. B.

(142.) 1873. OELLACHER, JOSEF. Beiträge zur Entwicklung der Knochenfische, &c. Zeitschrift für Wiss. Zoologie, Bd. 23.

(143.) 1873. STIEDA, Dr. LUDWIG. Ueber die Deutung der einzelnen Theile des Fischgehirns. Zeitschrift für Wiss. Zoologie, Bd. 23.

(144.) 1873. STIEDA, Dr. LUDWIG. Studien über den Amphioxus. Mémoires de l'Acad. Imp. des Sciences de St. Pétersbourg., vii[e] série, tome xix.

(145.) 1873. STIEDA, Dr. LUDWIG. Ueber den Bau des Rückenmarks der Rochen und der Haie. Zeitschrift für Wiss. Zoologie, Bd. 23.

(146.) 1874. BRÜCKE, ERNST. Vorlesung über Physiologie, Bd. ii. Wien.

(147.) 1875. ARNDT, RUD. Untersuchungen über die Ganglienkörper der Spinalganglien. Archiv für Mik. Anatomie, Bd. xi.

(148.) 1875. DOHRN, ANTON. Ursprung der Wirbelthiere.

(149.) 1875. FRITSCH, G. Bericht über den Verlauf unternommenen wissenschaftlichen Expedition nach Klein Asien. Monatsberichte der preussischen Akad. der Wissenschaften.

(150.) 1875. GOETTE, Dr. ALEXANDER. Die Entwicklungsgeschichte der Unke (Bombinator igneus).

(151.) 1875. HOLL, M. Ueber den Bau der Spinalganglien. Sitzungsberichte de. kais. Akademie der Wissenschaften, Wien, Bd. lxxii.

(152.) 1875. KEY und RETZIUS. Studien in der Anatomie des Nervensystems uno des Bindegewebes. Stockholm.

(153.) 1875. RAUBER, Prof. Ueber den Bau der Gehirnnerven-Ganglien. Sitzungsberichte der Naturf. Gesellschaft zu Leipzig. Zweiter Jahrgang

(154.) 1875. STIEDA, Dr. LUDWIG. Ueber den Bau des centralen Nervensystems der Axlotl. Zeitschrift für Wiss. Zoologie, Bd. 25.

(155.) 1875. WILDER, Prof. BURT. G. Notes on the North American Ganoids. Proc. American Association Advancement of Science.

(156.) 1876. BALFOUR, F. M. On the spinal nerves of Amphioxus. Journal of Anatomy and Physiology, vol. x.

(157.) 1876. BOLL, Prof. Neue Untersuchungen zur Anatomie und Physiologie von Torpedo. Monatsberichte der Berliner Akademie, Nov. 1875.

(158.) 1876. Huxley, Prof. Contributions to Morphology. Ichthyopsida.—No. 1. On Ceratodus Forsteri. Proc. Zool. Society.

(159.) 1876. Jackson, Wm. Hatchett and Wm. Bruce Clarke. The brain and cranial nerves of Echinorhynus spinosus. Journal of Anatomy and Physiology, vol. x.

(160.) 1876. Key, Axel und Gustav Retzius. Studien in der Anatomie des Nervensystems, &c. Zweite Hälfte. Stockholm.

(161.) 1876. Langerhans, Prof. Dr. Paul. Zur Anatomie des Amphioxus lanceolatus. Archiv für Mik. Anatomie, Bd. xii.

(162.) 1876. Rauber, A. Ueber die caudal Intumescenz des Fischmarks. Sitzungsberichte Naturf. Gesellschaft zu Leipzig. Dritter Jahrgang.

(163.) 1876. Schwalbe, Prof. G. Bemerkungen über die Kerne der Ganglienzellen. Jenaische Zeitschrift, Bd. x.

(164.) 1876. Viault. Recherches histologiques sur la structure des centres nerveux des Plagiostomes. Arch. Zool. Expér., vol. v.

(165.) 1876. Wilder, Prof. Burt. G. Anterior brain mass with Sharks and Skates. American Journ. Science and Arts, vol. xii.

(166.) 1877. Babuchin, Prof. Beobachtungen und Versuche am Zitterwelse und Mormyrus des Nils. Archiv für Anatomie und Physiologie. Phys. Abth.

(167.) 1877. Calberla, Dr. E. Zur Entwicklung des Medullarrohres und der Chordadorsalis der Teleostier und der Petromyzonten. Morphologisches Jahrbuch, Bd. iii.

(168.) 1877. Denissenko, Gabriel. Zur Frage über den Bau der Kleinhirnrinde bei verschiedenen Klassen von Wirbelthieren. Archiv für Mik. Anatomie, Bd. 14.

(169.) 1877. Freud, Sigm. Ueber den Ursprung der hinteren Nervenwurzeln im Rückenmark von Ammocætes. Petromyzon planeri. Sitzungsberichte der k. Akademie der Wissenschaften, Wien, Bd. lxxv.

(170.) 1877. Wilder, Burt. G. On the brain of Chimæra monstrosa. Proc. Acad. Nat. Sciences, Philadelphia.

(171.) 1878. Balfour, F. M. A Monograph on the Development of Elasmobranch Fishes. London.

(172.) 1878. Daszkiewicz, Dr. Korybutt. Ueber die Entwicklung der Nerven aus Plasmazellen beim Frosche. Archiv für Mik. Anatomie, Bd. xv.

(173.) 1878. Ehlers. Die Epiphyse am Gehirn der Plagiostomum. Zeitschrift für Wiss. Zoologie, Bd. 30. Supplement.

(174.) 1878. Freud, Sigm. Ueber Spinalganglien und Rückenmark des Petromyzon. Sitzungsberichte der k. Akad. der Wissenschaften, Wien. Aus dem Physiologischen Institut der Wiener Universität.

(175.) 1878. FRITSCH, GUSTAV. Untersuchungen über den feineren Bau des Fischgehirns. Berlin.

(176.) 1878. GEGENBAUR, C. Grundriss der Vergleich Anatomie.

(177.) 1878. GOETTE, Dr. A. Ueber die Spinalnerven der Neunaugen. Zoologischer Anzeiger, Bd. 1.

(178.) 1878. GOETTE, Dr. A. Ueber die Spinalnerven der Neunaugen. Archiv für Mik. Anatomie, Bd. xv.

(179.) 1878. GOETTE, Dr. A. Ueber die Entwickelung des Centralnervensystems der Teleostier. Archiv für Mik. Anatomie, Bd. xv.

(180.) 1878. JHERING, HERMAN VON. Peripherische Nervensystem der Wirbelthiere. Leipzig.

(181.) 1878. REICHENHEIM, Dr. MAX. Ueber das Rückenmark und der electrischen Lappen von Torpedo. Berlin.

(182.) 1878. ROHON, JOSEF VICTOR. Ueber den Ursprung des Nervus Vagus bei Selachiern. Separat-Abdruck aus den Arbeiten des Zool. Instituts zu Wien, Heft 1.

(183.) 1878. ROHON, JOSEF VICTOR. Das Centralorgan des Nervensystems der Selachier. Wien. Akad. Denkschrift, Bd. 38.

(184.) 1878. SANDERS, ALFRED. Contributions to the Anatomy of the Central Nervous System in Vertebrate Animals. Teleostei. Phil. Trans.

(185.) 1878. SCHWALBE, Professor. Ueber die Morphologische Bedeutung des Ganglion Ciliare. Sitzungsberichte der Jenaischen Gesellschaft.

(186.) 1878. ZINCONE, ANTONIO. Sulle prominenze del medollo spinale dell' Trigle. Napoli.

(187.) 1879. BELLONCI, DOTT. G. Ricerche intorno all' intima tessitura del cervello dei Teleostei. Reale Accad. dei Lincei. Roma, anno cclxxvi.

(188.) 1879. FRIANT, A. Recherches anatomiques sur les nerfs trigumeaux et facial des Poissons osseux. Nancy.

(189.) 1879. JELANEFF, A. Histologische Untersuchungen des kleinen Gehirnes der Neunauge (Petromyzon fluviatilis). Bull. de l'Acad. Imp. de St. Pétersbourg, tome xxv.

(190.) 1879. MILNE-MARSHALL, Dr. A. Morphology of Vertebrate Olfactory Organ. Quarterly Jour. Mic. Science, vol. xix.

(191.) 1879. SCHNEIDER, Professor ANTON. Beiträge zur vergleichenden Anatomie und Entwicklungsgeschichte der Wirbelthiere. Berlin.

(192.) 1879. SCHWALBE, Professor G. Das Ganglion Oculomotorii. Jenaische Zeitschrift, Bd. 13.

(193.) 1879. SCOTT, W. B. and H. F. OSBORN. On some points in the Early Development of the Common Newt. Quarterly Jour. Mic. Science, vol. xix.

(194.) 1879. WIEDERSHEIM, Dr. R. Zur Anatomie des Amblystoma Weismanni. Zeitschrift für Wiss. Zool., Bd. 32.

(195.) 1879. Wiedersheim, Dr. R. Die Anatomie der Gymnophionem. Jena. Fischer.

(196.) 1880. Balfour, F. M. On the Spinal Nerves of Amphioxus. Quarterly Jour. Mic. Science.

(197.) 1880. Bellonci, Dr. Joseph. Ueber der Ursprung des Nerven opticus und den feineren Bau des Tectum opticum der Knochenfische. Zeitschrift für Wiss. Zool., Bd. xxxv.

(198.) 1880. Bellonci, G. Ricerche comparative sulla struttura dei centri nervosi dei Vertebrati. Reale Accad. dei Lincei, anno cclxxvii.

(199.)* 1880. Blaschko, A. Das Sehcentrum bei Fröschen. Inaugural Dissertation.

(200.) 1880. Fritsch, G. Zur Anatomie des Fischgehirns. Archiv für Anatomie. Phys. Abth.

(201.) 1880. Rabl-Rückhard. Deutung der einzelnen Theile des Fischgehirns. Morphologisches Jahrbuch, Bd. vi.

(202.) 1880. Rawitz, Bernard. Ueber den Bau der Spinalganglien. Archiv für Mik. Anatomie, Bd. xviii.

(203.) 1880. Retzius, Professor Gustav. Untersuchungen über die Nervenzellen der cerebrospinalen Ganglien und der übrigen peripherischen Kopfganglien. Archiv für Anatomie. Anat. Abth.

(204.) 1880. Scott, W. B. Vorläufige Mittheilungen über die Entwicklungsgeschichte der Petromyzon. Zool. Anzeiger, Bd. iii.

(205.) 1880. Wiedersheim, Dr. R. Morphologische Studien. Jena. Gustav Fischer.

(206.) 1880. Wiedersheim, Professor R. Zur Anatomie des Froschgehirns. Zool. Anzeiger, Bd. iii.

(207.) 1880. Wiedersheim, Professor R. Ueber den Ursprung des Nervus Acusticus. Zool. Anzeiger, Bd. iii.

(208.) 1881. Beauregard. Encéphale et nerfs craniens du Ceratodus Forsteri. Journal de l'Anatomie et Physiologie. Ch. Robin et G. Pouchet.

(209.) 1881. Bellonci, Dr. G. Sulla regione ottica cerebrale dei Pesci e degli Anfibi. Rendiconti dell Accad. delle Scienze dell' Instituto di Bologna.

210.) 1881. Cattie, J. Th. Epiphysis Cerebri der Plagiostomi Ganoidei en Teleostei (Dutch). Leiden.

(211.) 1881. Hatschek, B. Studien über Entwicklung des Amphioxus. Arbeiten aus dem Zool. Institute der Univ. Wien, tome iv., Heft 1.

(212.) 1881. Krause, W. Ueber die Doppelnatur des Ganglion ciliare Morphologisches Jahrbuch, Bd. 7.

(213.) 1881. Milne Marshall, Dr. A., and W. Baldwin Spencer. Observations on the Cranial Nerves of Scyllium. Quarterly Journal Mic. Science, vol. xxi.

(214.) 1881. MILNE MARSHALL, Dr. A. On the Head Cavities and Associated Nerves of the Elasmobranches. Quarterly Journal Mic. Science, vol. 21.

(215.) 1881. MAYSER, Dr. P. Vergleichend anatomische Studien über das Gehirn der Knochenfische. Zeitschrift für Wiss. Zool., Bd. 36.

(216.) 1881. RETZIUS, GUSTAV. Das Gehörorgan der Wirbelthiere, Bd. 1. Stockholm.

(217.) 1881. SACHS, CARL. Untersuchungen am Zitteraal, Anhang 1. Das Gehirn und Rückenmark des Gymnotus electricus, von G. FRITSCH.

(218.) 1881. SCOTT, W. B. Preliminary Accounts of the Development of the Lamprey. Quarterly Journal Mic. Science, vol. xxi.

(219.) 1881. VIGNAL, WILLIAM. Note sur l'anatomie des centres nerveux du mole (Orthagoriscus mola). Archiv de Zool. expér. et gén., tome 9.

(220.) 1882. AHLBORN, F. Zur Neurologie der Petromyzonten. Göttinger Nachrichten.

(221.) 1882. BALFOUR, F. M. and W. N. PARKER. Structure and Development of Lepidosteus. Phil. Trans.

(222.) 1882. BELLONCI, Professore G. Intorno alla struttura ed alle connessioni dei lobi olfattorii negli arthropodi superiori e nei vertebrati. Reale Accad. dei Lincei, anno clxxix.

(223.) 1882. BIRGE, E. A. Die Zahl der Nervenfasern und der motorische und Ganglienzellen im Rückenmark des Frosches. Archiv für Anat. Phys. Abth.

(224.) 1882. CATTIE, Professor J. Th. Recherches sur la glande pinéale des Plagiostomes, Ganoides et des Teleosteens. Archives de Biologie.

(225.) 1882. DOHRN, Dr. ANTON. Die Entstehung der Hypophysis bei Petromyzon planeri. Zool. Anzeiger, Bd. v.

(226.) 1882. MILNE, MARSHALL, Dr. A. The segmental value of the cranial nerves. Journal of Anatomy and Physiology, vol xvi.

(227.) 1879–1882. MASON, Dr, JOHN J., M.D. Minute structure of the central nervous system of certain reptiles and batrachia. Newport.

(228.) 1882. OWEN, Prof. R. Conario Hypophysial tract. Journal Linnean Society.

(229.) 1882. RABL-RÜCKHARD, Dr. Zur Deutung und Entwicklung des Gehirns der Knochenfische. Archiv für Anatomie.

(230.) 1882. RABL-RÜCKHARD. Entwickelung des Knochenfischgehirns. Sitzungsberichte der Gesellsch. Natf. Freunde zu Berlin.

(231.) 1882. RAWITZ, BERNARD. Ueber den Bau der Spinalganglien. Archiv für Mik. Anatomie, Bd. 21.

(232.) 1882. ROHON, J. V. Ueber den Ursprung des Nervus Acusticus bei Petromyzonten. Sitzungsberichte der Wiener Akademie, Bd. 85, Abth. 1.

(233.) 1882. Rohon, J. V. Untersuchungen über Amphioxus lanceolatus. Denkschrift der k. Akademie der Wissenschaften, Wien, Bd. 45.

(234.) 1882. Sanders, Alfred. Contributions to the anatomy of the central nervous system in vertebrate animals. Teleostei, Mormyridæ. Phil. Trans.

(235.) 1882. Schneider, Dr. Heinrich. Ueber die Augenmuskelnerven der Ganoiden. Jenaische Zeitschrift, Bd. xv.

(236.) 1882. Ussow, Dr. M. De la structure des lobes accessoires de la moelle épinière de quelques poissons osseux. Archives de Biologie, tome iii.

(237.) 1879–1882. Wijhe, Dr. J. W. van. Ueber das Visceralskelet und die Nerven des Kopfes der Ganoiden und von Ceratodus. Niederländisches Archiv für Zoologie, Bd. v.

(238.) 1883. Ahlborn, Friedrich. Untersuchungen über das Gehirn der Petromyzonten. Zeitschrift für Wiss. Zoologie, Bd. 39.

(239.) 1883. Baudelot, Emile. Recherches sur le système nerveux des Poissons. Paris. Masson.

(240.) 1883. Goette, Dr. Alexander. Ueber die Entstehung des Hirnanhangs. Zoologischer Anzeiger, Bd. vi.

(241.) 1883. Klaussner, Dr. Ferdinand. Das Rückenmark des Proteus Anguineus. Abhandlungen der k. Bayerische Akademie, Bd. xiv.

(242.) 1883. Owsjannikow, Ph. Ueber das sympathische Nervensystem der Flussneunauge. Bull. de l'Acad. Imp. de St. Pétersbourg, tome xxviii.

(243.) 1883. Rabl-Rückhard. Das Grosshirn der Knochenfische und seine Anhangsgebilde. Archiv für Anatomie, Anat. Abth.

(244.) 1883. Rabl-Rückhard, Professor. Weiteres zur Deutung des Gehirns der Knochenfische. Biol. Centralblatt, Bd. iii.

(245.) 1883. Wijhe, Dr. J. W. van. Ueber die Mesodermsegmente und die Entwickelung der Nerven des Selachier Kopfes. Verhandlingen der kon. Akad. van Wetenschappen. In German, and also published separately.

(246.) 1884. Ahlborn, Fr. Ueber die Bedeutung der Zirbeldrüse. Zeitschrift für Wiss. Zoologie, Bd. 40.

(247.) 1884. Ahlborn, Fr. Ueber den Ursprung und Austritt der Hirnnerven von Petromyzon. Zeitschrift für Wiss. Zoologie, Bd. 40.

(248.) 1884. Bedot, Maurice. Recherches sur le développement des nerfs spinaux chez les tritons. Recueil Zoologique Suisse, vol. 1.

(249.) 1884. Fritsch, Professor G. Ueber den Angelapparat des Lophius piscatorius. Sitzungsberichte Akademie zu Berlin.

(250.) 1884. Frommen, Dr. C. Untersuchungen über Strucktur, Lebenserscheinungen und Reaktionen thierischer und pflanzlicher Zellen. Jenaische Zeitschrift, Bd. 17.

(251.) 1884. GORONOWITSCH, N. Vorläufige Mittheilung über die Entwicklung des Centralnervensystems bei Knochenfischen. Zool. Anzeiger.

(252.) 1884. HERMS, ERNST. Ueber die Bildungsweise der Ganglienzellen, &c., bei Ammocætes. Sitzungsberichte der k. baier. Akad. zu München, Bd. xiv.

(253.) 1884. OSBORN, DR. H. J. Observations upon the Urodele Amphibian Brain. Zool. Anzeiger, Bd. vii.

(254.) 1884. ROHON, VICTOR. Zur Histiogenese des Rückenmarkes der Forelle. Sitzungsberichte der k. baier. Akad. zu München, Bd. xiv.

(255.) 1884. SAGEMEHL, M. Beiträge zur vergleichenden Anatomie der Fische. Morphologisches Jahrbuch, Bd. ix.

(256.) 1885. BEARD, DR. J. On the Cranial Ganglia and Segmental Sense Organs of Fishes. Zool. Anzeiger.

(257.) 1885–6. GIERKE, HANS. Die Sitzsubstanz des Centralnervensystems. Archiv für Mik. Anatomie, Bd. xxv. and xxvi.

(258.) 1885. GORONOWITSCH, N. Studien über die Entwicklung des Medullarstranges bei Knochenfischen. Morphologisches Jahrbuch, Bd. x.

(259.) 1885. LEYDIG, FRANZ. Zelle und Gewebe. Bonn.

(260.) 1885. SCHMIDT, MAX. Beiträge zur Kenntniss des Rückenmarks der Amphibien. Zeitschrift für Naturwiss. Halle.

(261.) 1886. BOVERI, THEODORE. Beiträge zur Kenntniss der Nervenfasern. Abdhandl. k. bayerische Akad., Bd. xv.

(261.) 1886. FRITSCH, GUSTAV. Ueber einige bemerkenswerthe Elemente des Centralnervensystems von Lophius piscatorius. Archiv für Mik. Anatomie, Bd. xxvii.

(263.) 1886. FULLIQUET. Recherches sur le cerveau du Protopterus annectens. Recueil Zoologique Suisse, tome iii.

(264.) 1886. FUSARI, ROMEO. Ricerche intorno alla fina Anatomia dell' Encefalo dei Teleostei. Nota preventiva. Bullentino Scientifico, Anno viii. Pavia.

(265.) 1886. GRAAF, HENRI W. DE. Zur Anatomie und Entwicklung der Epiphyse bei Amphibien und Reptilien. Zool. Anzeigen, Jahrg. ix.

(266.) 1886. JOHNSON, ALICE, and LILIAN SHELDON. Notes on the Development of the Newt, Triton cristatus. Quarterly Journal Mic. Science.

(267.) 1886. LENHOSSÉK, MICHAEL VON. Untersuchungen über die Spinalganglien des Frosches. Archiv für Mik. Anatomie, Bd. xxvi.

(268.) 1886. NANSEN, FRIDTJOF. The Structure and Combination of the Histological Elements of the Central Nervous System. Bergens Museum, Aarsberetning. Bergen.

(269.) 1886. ONODI, A. D. Ueber die Entwicklung des Sympathischen Nerven systems. Archiv für Mik. Anatomie, Bd. xxvi.

(270.) 1886–7. OSBORN, DR. HENRY. The Origin of the Corpus Callosum: a Contribution upon the Cerebral Commissures of the Vertebrata. Morphologisches Jahrbuch, Bd. xii.

(271.) 1886. OSBORN, DR. HENRY J. Observations upon the presence of the Corpus Callosum in the Brain of Amphibians and Reptiles. Zool. Anzeiger.

(272.) 1886. RANSOM, W. B., and Professor D'ARCY W. THOMPSON. On the Spinal and Visceral Nerves of Cyclostomata. Zool. Anzeiger, Jahrgang ix.

(273.) 1886. RAUBER, A. Ueber die Mitosen des Medullarrohres. Zool. Anzeiger, Jahrgang ix.

(274.) 1886. SANDERS, ALFRED. Contributions to the Anatomy of the Central Nervous System in Vertebrate Animals. Plagiostomata, Phil. Trans., vol. 117.

(275.) 1887. BEARD, J. The Ciliary or Motor-oculi Ganglion and the Ganglion of the Ophthalmicus profundus in the Shark. Anatomischer Anzeiger.

(276.) 1887. BELLONCI, Prof. G. Intorno all' apparato olfattivo ottico (nuclei rotondi FRITSCH) dell cervello dei Teleostei. Atti della R. Accad. dei Lincei, serie quarta, vol. 1.

(277.) 1887. BELLONCI, Prof. GIUSEPPE. Sulle commissure cerebrale anteriori degli amfibi e dei rettili. Bologna.

(278.) 1887. BÉRANECK, Dr. ED. Ueber das Parietalauge der Reptilien. Jenaische Zeitschrift, Bd. xxi.

(279.) 1887. EDINGER, Dr. L. Vergleichende Entwicklungsgeschichte. Studien im Bereich der Gehirn-Anatomie. Anat. Anzeiger.

(280.) 1887. FUSARI, ROMEO. Intorno alla fina anatomia dell encefalo dei Teleostei. Atti della R. Accad. dei Lincei, anno cclxxxiv.

(281.) 1887. HIS, WILLIAM. Die morphologische Betrachtung der Kopfnerven. Eine kritische Studie. Archiv für Anatomie, Anat. Abth.

(282,) 1887. IVERSEN, M. Bemerkungen über die dorsalen Wurzeln des Nervus hypoglossus. Berichte der Naturf. Gesellschaft zu Freiburg, Bd. ii.

(283.) 1887. JULIN, CHARLES. Le système nerveux grand sympathique de l'Ammocætes (Petromyzon planeri). Anat. Anzeiger.

(284.) 1887. JULIN, CHARLES. Recherches sur l'appareil vasculaire et le système nerveux périphérique de l'Ammocætes (Petromyzon planeri). Archives de Biologie, tome vii.

(285.) 1887. JULIN, CHARLES. De la valeur morphologique du nerf latéral du Petromyzon. Bull. de l'Acad. Royale de Belgique, tome xiii.

(286.) 1887. Kölliker, A. v. Ueber das Zirbel- oder Scheitelauge. Sitzungsberichte Phys.-Med. Gesellschaft zu Würzburg.

(287.) 1887. Leydig, F. Das Parietalorgan der Wirbelthiere. Zool. Anzeiger.

(288.) 1887. Onodi, A. D. Neurologische Mittheilungen. Archiv für Anatomie, Phys. Abth.

(289.) 1887. Peytoureau, A. La glande pinéale et le troisième œil des vertébrés. Paris. Octave Doin.

(290.) 1887. Rabl-Rückhard. Zur onto- und phylogenetischen Entwicklung des Torus longitudinalis im Mittelhirn der Knochenfische. Anat. Anzeiger.

(291.) 1887. Le Roux, Marc. Recherches sur le système nerveux des Poissons. Caen.

(292.) 1887. Sarasin, Dr. Paul und Dr. Fritz Sarasin. Ergebnisse naturwissenschaftlicher Forschungen auf Ceylon. Zur Entwicklungsgeschichte und Anatomie der Ceylonesischen Blindwühle (Ichhyophis glutinosus).

(293.) 1887. Schiefferdecker, Dr. P. Beiträge zur Kenntniss des Baus der Nervenfasern Petromyzon. Archiv für Mik. Anatomie, Bd. xxx.

(294.) 1887. Schulzin.* Ueber den Bau des centralen Nervensystems der Amphibien und Reptilien. Schriften der Neurussischen Gesellschaft in Odessa.

(295.) 1887. Scott, W. B. Notes on the development of Petromyzon. Journal of Morphology, vol. 1.

(296.) 1887. Shipley, Arthur E. On some points in the development of Petromyzon fluviatilis. Quarterly Journal Mic. Science, vol. xxvii.

(297.) 1887. Waldschmidt, Dr. Julius. Zur Anatomie des Nervensystems der Gymniophonen. Jenaische Zeitschrift, Bd. xx.

(298.) 1887. Waldschmidt, Dr. Julius. Beitrag zur Anatomie des Zentralnervensystems und des Geruchsorgans von Polypterus bichir. Anat. Anzeiger.

(299.) Wilder, Prof. Burt. G. The Dipnoan brain. Ceratodus. American Naturalist, vol. xxi.

(300.) 1888. Auerbach, Dr. L. Die Lobi optici der Teleostier und die Vierhügel der höher organisirten Gehirne. Morphologisches Jahrbuch, Bd. 14.

(301.) 1888. Beard, J. The old mouth and the new. A study in vertebrate morphology. Anat. Anzeiger.

(302.) 1888. Beard, J. A contribution to the morphology and development of the nervous system of Vertebrates. Anat. Anzeiger.

(303.) 1888. Beard, J. Morphological studies. No. II. Development of the peripheral nervous system of Vertebrates. Part 1. Elasmobranchii and Aves. Quarterly Journal Mic. Science.

(304.) 1888. BEARD, J. Morphological studies. The parietal eye of cyclostome fishes. Quarterly Journal Mic. Science, 3rd series, vol. vii.

(305.) 1888. CARR, J. W. Anatomy and development of the Lancelet. Amphioxus lanceolatus. Trans. Nottingham Naturalists Society.

(306.) 1888. CHEVRAL RENÉ. Sur le système nerveux grand sympathique des poissons osseux. Comptes Rendus, vol. cvii. Also published separately.

(307.) 1888. DOHRN, ANTON. Ueber Nerven und Gefässe bei Ammocætes und Petromyzon planeri. Mittheilungen aus der Zool. Station zu Neapel, Bd. viii.

(308.) 1888. EDINGER, DR. LUDWIG. Untersuchungen über die vergleichende Anatomie des Gehirns. 1. Das Vorderhirn. Abhandlungen, hergegeben Senckenbergische Gesellschaft, Bd. 15. Frankfurt a. M.

(309.) 1888. GEGENBAUR, C. Die Matamerie des Kopfes und die Wirbeltheorie des Kopfskeletes. Morphologisches Jahrbuch, Bd. 13.

(310.) 1888. GOETTE, A. Ueber die Entwicklung von Petromyzon fluviatilis. Zool. Anzeiger, Jahrgang xi.

(311.) 1888. GORONOWITSCH, N. Das Gehirn und die Cranialnerven von Acipenser ruthenus. Morphologisches Jahrbuch, Bd. 13.

(312.) 1888. HENNEGUY, L. FELIX. Recherches sur le développement des Poissons osseux. POUCHET, Journal de l'Anatomie et de la Physiologie.

(313.) 1888. JAKINOWITSCH, DR. J. Sur la structure du cylindreaxe et des cellules nerveux. POUCHET, Journal de l'Anatomie et de la Physiologie.

(314.) 1888. JOSEPH HR. Zur feineren Structur der Nervenfasern. Archiv. für Anatomie. Phys. Abth.

(315.) 1888. JULIN CH. Sur l'appareil vasculaire et le système nerveux périphérique de l'Ammocætes. Zool. Anzeiger, Jahrgang xi.

(316.) 1888. KASTSCHENKO, DR. MAX. Entwicklungsgeschichte des Selachierembryos. Anat. Anzeiger.

(317.) 1888. KÖPPEN, DR. MAX. Anatomie des Froschgehirns. Archiv. für Anatomie. Anat. Abth.

(318.) 1888. KUPFFER, C. Ueber die Entwicklung von Petromyzon planeri. Sitzungsberichte der k. baier. Akademie, München.

(319.) 1888–1889. OSBORN, Prof. H. F. A Contribution to the Internal Structure of the Amphibian Brain. Journal of Morphology. Vol. ii.

(320.) 1888. OWSJANNIKOW, PH. Ueber das dritte Auge bei Petromyzon fluviatilis. Mém. de l'Acad. Imp. de St. Pétersbourg. VII[e] serie, tome xxxvi.

(321.) 1888. ROHDE, DR. EMIL. Histologische Untersuchungen über das Nervensystem von Amphioxus. Zool. Anzeiger. Jahrgang xi.

(322.) 1888. SHORE, DR. THOS. W. The Morphology of the Vagus Nerve. Journal of Anatomy and Physiologie. Vol. xxii.

(323.) 1888. WHITWELL, Dr. JAMES R. The Epiphysis cerebri in Petromyzon fluviatilis. Journal of Anatomy and Physiology, vol. xxii.

(324.) 1889. BEARD, J. On the Early Development of the Lepidosteus Osseus. Preliminary notice. Proc. Royal Society.

(325.) 1889. BURCKHARDT, KARL RUDOLF. Histologische Untersuchungen am Rückenmark der Tritoneus. Archiv für Mik. Anatomie. Bd. xxxiv.

(326.) 1889. CARRIÈRE. Neuere Untersuchungen über das Parietalorgan. Biologisches Centralblatt. Bd. 9.

(327.) 1889. CHATIN, JOANNES. Sur les homologies des lobes inférieurs du cerveau des Poissons. Comptes Rendus, vol. cviii., p. 628.

(328.) 1889. CHATIN, JOANNES. Sur les myélocytes des Poissons. Comptes Rendus, vol. cix., p. 745.

(329.) 1889. EDINGER, Dr. L. Vergleichende Entwicklungsgeschichte und anatomische Studien im Bereiche des Centralnervensystems. Anat. Anzeiger.

(330.) 1889. EWART, Dr. J. C. On the Cranial Nerves of the Elasmobranch Fishes. Preliminary communication. Proc. Royal Society.

(331.) 1889. FRITSCH, G. Ueber das numerische Verhältniss der Ganglienzellen im Lobus electricus der Torpidineen. Archiv für Anatomie. Phys. Abth.

(332.) 1889. FROMMEN, Dr. C. Beiträge zur Kenntniss der Lebensvorgänge in thierischen Zellen. Jenaische Zeitschrift.

(333.) 1889. HIS, W. Die Neuroblasten und deren Entstehung im embryonalen Mark. Archiv für Anatomie. Anat. Abth.

(334.) 1889. HOUSSAY, M. F. Études d'embryologie sur l'axolotl. Comptes Rendus, vol. cix. p. 703.

(335.) 1889. LEYDIG, F. Das Parietalorgan der Reptilien und Amphibien kein Sinneswerkzeug. Biologisches Centralblatt. Bd. 8.

(336.) 1889. MCCLURE, CHARLES F. W. The Primitive Segmentation of the Vertebrata Brain. Zool. Anzeiger. Jahrgang xii.

(337.) 1889. ORR, HENRY. Note on the Development of Amphibian Central Nervous System. Quarterly Journal Mic. Science.

(338.) 1889. OSTRONMOFF, A. Ueber die Froriepschen Ganglien bei Selachiern. Zool. Anzeiger, Jahrgang xii.

(339.) 1889. SANDERS, ALFRED. Contributions to the anatomy of the central nervous system in Ceratodus Forsteri. Annals and Magazine of Natural History.

(340.) 1889. SHORE, Dr. TH. W. On the minute anatomy of the vagus nerve in Selachians. Journal of Anatomy and Physiology, vol. xxiii.

(341.) 1889. AYERS, HOWARD. Concerning vertebrate cephalogenesis. Journal of Morphology, vol. iv.

(342.) 1890. Beard, J. The Interrelationships of the Ichthyopsida. Anat. Anzeiger.

(343.) 1890. Chevrel, R.* Sur l'anatomie du système nerveux grand sympathique des élasmobranches et des poissons osseux. Thèse. Poitiers.

(344.) 1890. Ewart, Dr. J. C. On the development of the ciliary or motor oculi ganglion. Proc. Roy. Soc.

(345.) 1890. Ewart, Dr. J. C. The cranial nerves of the torpedo. Proc. Roy. Soc.

(346.) 1887–1890. Fritsch, Professor Gustav. Die electrischen Fische. Torpedo. Leipzig.

(347.) 1890. Gaskell, W. H. On the origin of the vertebrates from a crustacean-like ancestor. Quarterly Journal Mik. Science.

(348.) 1890. Guitel, Frederic. Sur le nerf lateral des cyclopterdés. Comptes Rendus, vol. iii.

(349.) 1890. Holt, Ernest W. L. Some stages in the development of Clupea harengus. Proc. Roy. Soc.

(350.) 1890. Kupffer, C. Die Entwicklung von Petromyzon planeri. Archiv für Mik. Anatomie, Bd. 35.

(351.) 1890. Leydig, Dr. Franz. Das Pariatalorgan der Amphibien und Reptilien. Abhandlungen herausgegeben von der Senckenbergischen Gesellschaft, Frankfurt-a.-M.

(352.) 1890. McClure, Charles F. W. The segmentation of the primitive vertebrate brain. Part 1. Journal of Morphology, vol. iv.

(353.) 1890. Nakagawa, Isaac. Origin of cerebral cortex. Journal of Morphology, vol. iv.

(354.) 1890. Oyarzun, Dr. A. Ueber den feineren Bau des Vorderhirns der Amphibien. Archiv für Mik. Anatomie, Bd. 35.

(355.) 1890. Retzius, Professor Gustav. Biologische Untersuchungen. Neue Folge, 1. Stockholm.

(356.) 1890. Smirnow, Alexis. Die Strucktur der Nervenzellen im Sympathicus der Amphibien. Archiv für Mik. Anatomie, Bd. 35.

(357.) 1890. Strong, Oliver. The structure and homologies of the cranial nerves of the Amphibia. Zool. Anzeiger, Bd. xiii.

(358.) 1890. Whitman, A. C. On the ventricular epithelium of the frog's brain. * Inaugural Dissertation. Baltimore.

(359.) 1890. Wiedersheim, R. Beiträge zur Entwicklungsgeschichte von Proteus anguineus. Archiv für Mik. Anatomie, Bd. 35.

(360.) 1891. Burckhardt, Dr. Rud. Die Zirbel von Ichthyophis glutinosus und Protopterus annectens. Anat. Anzeiger, Jahrgang, vi.

(361.) 1891. Burckhardt, Dr. Rud. Untersuchungen am Hirn und Geruchsorgan von Triton und Ichthyophis. Zeitschrift für Wiss. Zoologie, Bd. 52.

(362.) 1891. CAJAL, S. R.* Pequenas contribuciones al conoscimiento del sistema nervioso. 2. Grundbau der Grosshirnrinde der Batrachier, &c. Barcelona.

(363.) 1891. FRORIEP, AUG. Ueber die Entwicklung des Sehnerven. Anat. Anzeiger. Jahrgang vi.

(364.) 1891. HALLER, B. Ueber das Centralnervensystem, insbesondere über das Rückenmark von Orthagoriscus mola. Morphologisches Jahrbuch, Bd. 17.

(365.) 1891. HERRICK, C. L. The Commissures and Histology of the Teleost Brain. Anat. Anzeiger. Jahrgang vi.

(366.) 1891. * HERRICK, C. L. Contributions to the Morphology of the Brain of Bony Fishes. Journ. of Comparative Neurology, vol. 1. Cincinnati.

(367.) 1891. LAVDOWSKY, M. Vom Aufbau des Rückenmarks. Archiv für Mik. Anatomie, Bd. 38.

(368.) 1891. * OWSJANNIKOW. Zur Entwickelungsgeschichte des Flussneunauges. Bull. de l'Acad. des Sciences de St. Pétersbourg. New series.

(369.) 1891. PLATT, JULIA B. Further Contributions to the Morphology of the Vertebrata Head. Anat. Anzeiger. Jahrgang vi.

(370.) 1891. PLESSON, Baron JOS. VON, und Dr. JOHN RABINOVICZ. Die Kopfnerven von Salamandra maculata. München.

(371.) 1891. POLLARD, H. B. On the Anatomy and Phylogenetic position of Polypterus. Anat. Anzeiger. Jahrgang vi.

(372.) 1891. RETZIUS, Dr. GUSTAV. Biologische Untersuchungen. Neue Folge, ii.

(373.) 1891. * SMIRNOW, A. Materialen zur Histologie des perif. Nervensystems der Batrachier. Russian. Kasan.

(374.) 1891. VALENTI, G. Contributo alla istogenesi della cellula nervosa, e della nevroglia nel cervello di alcuni pesci condrostei. Atti della societá Toscana di Siena, tome xii.

(375.) 1892. ANDERSON, OSKAR A. Zur Kentniss des sympathischen Nerven der urodelen Amphibien. Zoologisches Jahrbuch. Anat. Abth., Bd. v.

(376.) 1892. BEARD, J. The Transient Ganglion Cells and their Nerves in Raia batis. Anat. Anzeiger.

(377.) 1892. BURKCHARDT, Dr. RUDOLF. Das Centralnervensystem von Protopterus annecteus. Berlin. FRIEDLÄNDER and SOHN.

(378.) 1892. EDINGER, Dr. LUDWIG. Untersuchungen über die vergleichende Anatomie des Gehirns. 2. Das Zwischenhirn. Frankfurt-à-M. Diesterweg.

(379.) 1892. HERRICK, C. L. Additional notes on the Teleost Brain. Anat. Anzeiger.

(380.) 1892. Lenhossék, M. V. Beobachtungen an den Spinal Ganglien und dem Rückenmarks. Anat. Anzeiger.

(381.) 1892. Platt, Julia B. Fibres connecting the Central Nervous System and Chorda in Amphioxus. Anat. Anzeiger.

(382.) 1892. Pollard, H. B. On the Anatomy and Phylogenetic Position of Polypterus. Zool. Jahrbücher. Abth. für Anat., Bd. v.

(383.) 1892. Sala, C. L.* Estructure de la Medula espinal de los Batracios. Barcelona.

(384.) 1892. Sclavunos, Dr. G. Beiträge zur feineren Anatomie des Rückenmarks der Amphibien. Engelmann. Leipzig.

(385.) 1892. Sedgewick, Adam. Notes on Elasmobranch Development. Quarterly Journal Mic. Science, vol. 33

(386.) 1892. Strong, Oliver S. Structure and Homologies of the Cranial Nerves of Amphibia. Anat. Anzeiger.

(387.) 1892. Waters, Bertram H. Primitive Segmentation of the Vertebrate Brain. Quarterly Journal Mic. Science, vol. 33.

(388.) 1892. Wilder, Harris H. Die Nasengegend von Menopoma Alleghaniense und Amphiuma tridactylum. Zool. Jahrbücher. Abth. für Anat., Bd. v.

(389.) Rex, H. Beiträge zur Morphologie der Hirnnerven der Amphibien. * Morphologisches Jahrbuch, Bd. 19.

(390.) Birge, E. A. On the Motor Ganglion Cells of the Frog's Spinal Cord. * Trans. Wisconsin Acad., vol. 6.

(391.) 1892. Fritsch, Gustav. On the Origin of the Electric Nerves in Torpedo, * Mormyrus, and Malapterurus. Rep. British. Ass., 82nd Meeting, Edinburgh.

(392.) 1893. Burckhardt, Rudolf. Die Homologieen des Zwischenhirndaches, &c. Anatomischer Anzeiger, Bd. ix, Dec., Nos. 5 and 6.

(393.) 1893. Locy, Wm. A. The Derivation of the Pineal Eye. Anatomischer Anzeiger, Bd. ix, Dec.

(394.) 1893. Rabl-Rückhardt. Der Lobus Olfactorius impar der Selachier. Anatomischer Anzeiger, Jahrgang viii, Sept.

(395.) 1893. Schaper, Dr. Alfred. Zur ferneren Anatomie des Kleinhirns der Teleostier. Anatomischer Anzeiger, Jahrgang viii, Nos. 21 and 22.

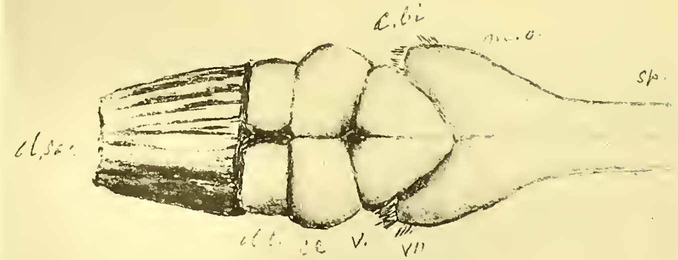

Fig. 1. ×6

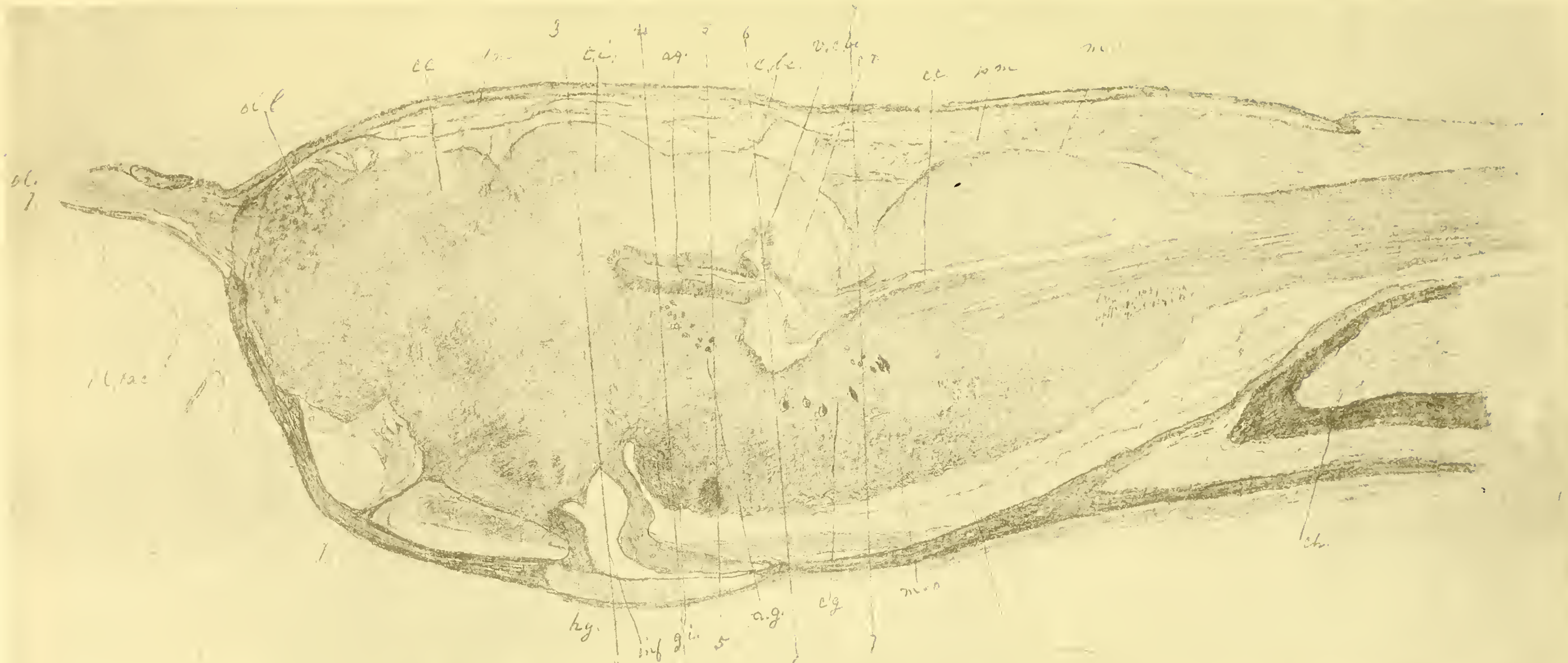

Fig. 2 × 25

Fig 3 × 25

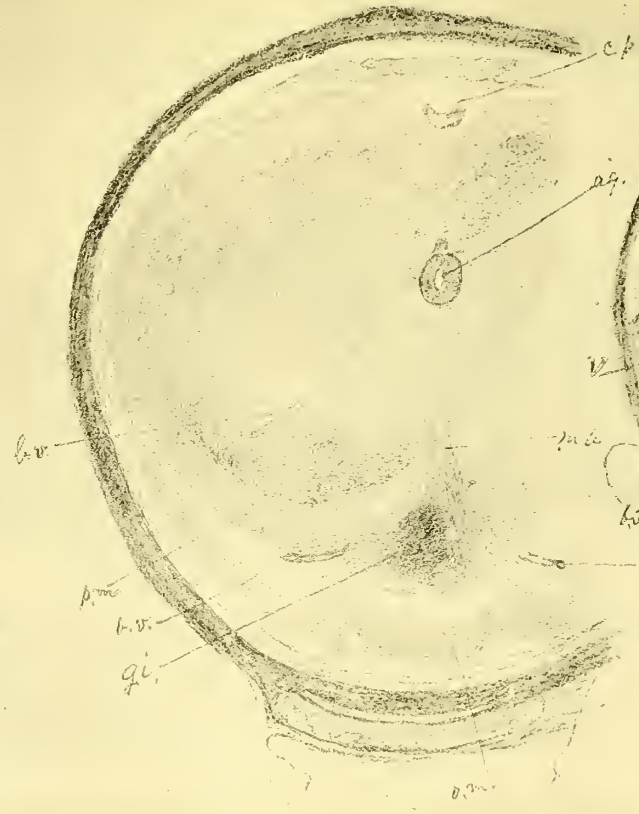

Fig 4 × 25

× 25

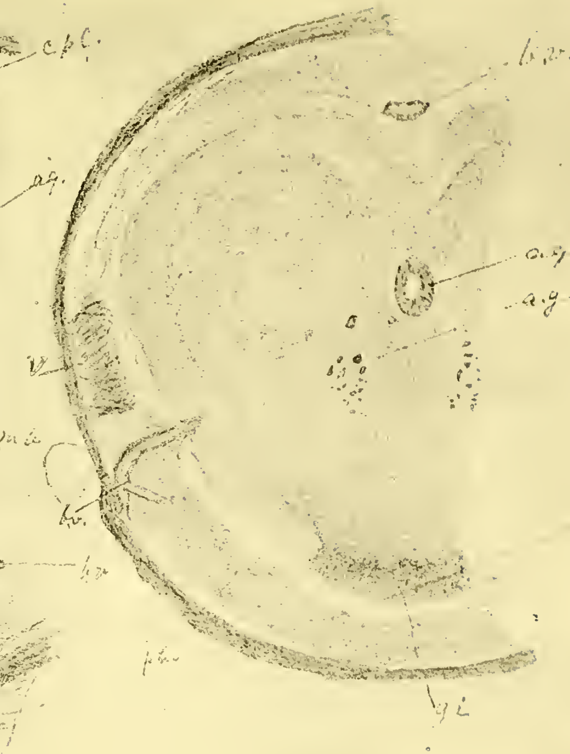

Fig 5 × 25

Fig. 6 ×42

Fig. 7.

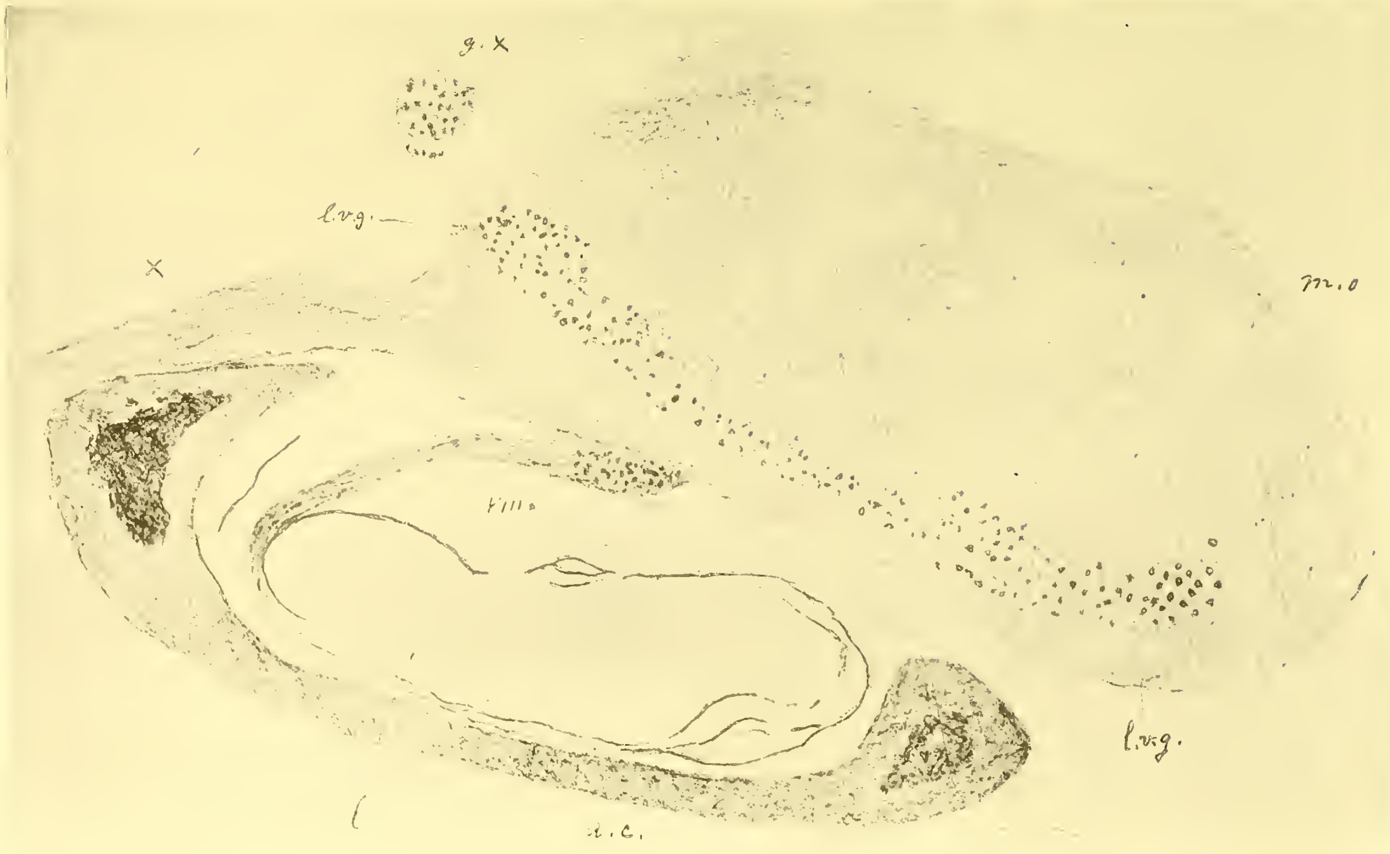

Fig. 8. X 42

Fig 10 × 200

Fig. 14

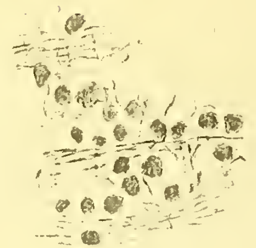
Fig 13
x340

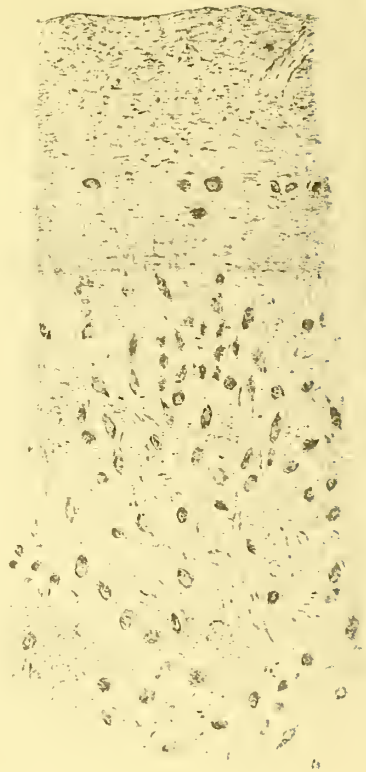
Fig 12
x 200

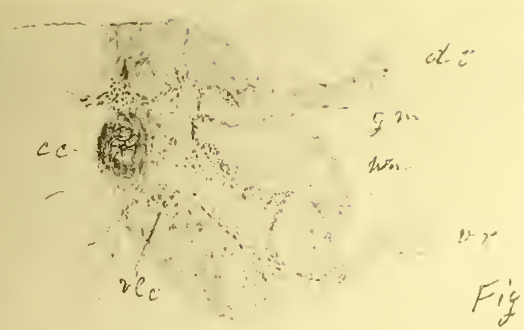

Fig 4
× 42

Fig. 5
× 46